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SMART STORYTELLING TO ENHANCE ENGAGEMENT IN TREATMENTS FOR NONCOMMUNICABLE DISEASE PATIENTS

Master of Science Thesis

Examiner: PhD. Heli Väätäjä
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ABSTRACT

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Humanity is becoming more and more adept to technology, embracing it in all areas of life. From knowledge to security, hopes are increasing regarding the solution of problems that were once seen as impossible to control. In developing countries, where medical resources are becoming scarce but human capital is growing, massive and effective responses are needed to prevent and halt the expansion of unhealthy conditions. A vital topic to address is that of healthcare and the impact of changes in habits to improve following treatment regimens. Fortunately, this sector can now find support in tools whose purpose it predominantly to entertain but that may help in dealing with the hardships of living with a chronic disease.

Finding cohesive solutions among different fields of study -such as arts, science and engineering- is not a straightforward task. In this work, noncommunicable diseases serve as the inspiration to design a tool that can help patients engage with their regimens by using interactive telenovelas (i.e. soap operas) to entertain and promote self-reflection. To analyze the impact of this tool, the research revolves around two inquiries: how is smart storytelling experienced by noncommunicable disease patients and in what ways are dimensions of engagement stimulated by smart storytelling. To develop this idea, an extensive process was performed through a literature review, ideation & prototypes, an implementation of the final concept (Chreune) and the validation of the tool with a modest set of potential users in a developing country: Mexico. The analysis of the evaluation outcomes brings to light that patients can engage with interactive telenovelas and question their own actions when the plot depends on them.

The work illustrates a viable path between medical and entertainment fields that may lead to a more enticing way of dealing with prevention and/or treatment of noncommunicable diseases.

PREFACE

This work is inspired by the impressive penetration of entertainment in everyday lives, as well as the joy it brings to those who may be in despair.

Above all, this work is meant to change the perspective of my family and friends who are going under long-term treatments. I hope this work helps them realize that there is an opportunity to enjoy life in a different way.

I want to recognize the effort and feedback provided by my examiner Heli Väätäjä and my supervisor Christopher Harris. Their guidance and support throughout the writing of this work was crucial for its development and will forever be deeply appreciated.

Special thanks to my friends for being supportive during this whole process. Whether it was by encouraging me with kind words or creating fun & healthy experiences beyond the text-editor screen, you always looked out for my own well-being and that -as I have learned- is not an easy task to do. *Kiitos! ¡Gracias! Teshekular! Terima kasih! Nandri! Thank you!*

Most of all, I am profoundly grateful to my family. To my sister, my example of enthusiasm for making the world a better place. To my dad, a proud sponsor of this research and unconditional rock. Finally, to my mom, who has showed me that a disease does not control someone but emphasizes the need to prioritize things in life. *Los quiero mucho y no podría haberlo hecho sin ustedes.*

Tampere, 16.11.2018

Paulina María Durán Miranda

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LIST OF SYMBOLS AND ABBREVIATIONS

CTML	Cognitive Theory of Multimedia Learning
FBM	Fogg Behavior Model
GUI	Graphical User Interface
HCI	Human-Computer Interaction
ISO	International Organization of Standardization
NCD	Noncommunicable disease
NPS	Net Promoter Score
SDT	Self-determination theory
PCI	Population Communications International
PFE	Patient and Family Engagement
PMC	Population Media Center
PHE	Patient Health Engagement
RAI	Relative Autonomous Index
QS	Quantified Self
UEQ	User Experience Questionnaire
W3C	World Wide Web Consortium
WHO	World Health Organization

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1. INTRODUCTION

With an increase in pervasive systems, different sectors gravitate towards the objective of including them as part of their services. One important player in these dynamics is the healthcare industry, which attempts to seize opportunities offered by ubiquitous computing [198]: being everywhere and understanding the context. These two features aid in forming digital solutions which can rapidly adhere to our day to day living. In developing countries, prompt responses are needed to tackle issues at the risk of becoming national threats. This scenario has encouraged the thesis work presented, which aims to support high blood pressure and diabetic patients in becoming more conscious of their actions by providing an entertaining tool to do so. This thesis work develops the concept of a smart interactive storytelling system named Chreune and its effects on patient engagement. Chreune presents the user with the possibility to determine the course of a narrative by using their glucose or blood pressure measurements as inputs that unlock multiple endings.

This chapter presents the two main topics that have set the ground for this research work: noncommunicable diseases and telenovelas. Afterwards, the research goals and questions are explained. Lastly, an outline of the thesis work is introduced to depict the structure to be followed.

1.1 Background and motivation

The continuous growth of population -in low and middle-income countries [8][9] - has created a bigger demand in services such as distribution of goods, safety and healthcare. This last rubric is addressed by the World Health Organization (WHO), which considers noncommunicable diseases (NCD) as the biggest threat to human development. Accounting for 68% of deaths in the world [1], noncommunicable diseases (also known as "chronic diseases") are described as non-contagious, long-lasting and degenerative. Due to their magnitude, the WHO has stipulated voluntary global targets for prevention and control of noncommunicable diseases to be attained by 2020 [46]. The targets contemplate cancer, diabetes, cardiovascular and chronic respiratory diseases. However, this variety has found common grounds in the root causes that detonate them. Furthermore, NCDs have been appointed as outcomes of biological and behavioral factors [2]. An opportunity rises as these latter ones can be modified by reshaping lifestyle habits.

WHO's Global NCD Action plan [46] consists of 25 indicators, where 10 of them fall under the "behavior risks" category. The category depicts eating habits, physical activity and consumption of harmful substances (i.e. alcohol and tobacco) as the main issues to concentrate on. Along with the indicators, 6 out of the 9 voluntary global targets in the Action plan point to cardiovascular or diabetes related affairs. For the purpose of this work, cardiovascular and diabetes conditions have been selected due to the ongoing increase in their occurrence worldwide [1]. Whereas noncommunicable diseases become a flourishing menace, simpler and effective treatments fighting them seem to be insufficient.

Nonetheless, healthcare is not the only area that has witnessed a boost in demand of services. Likewise, the media & entertainment industry has embraced technologies to reach an increasing the number of consumers. While both healthcare and entertainment might seem distant from each other, they both share the desire to create true engagement in their users.

Media entertainment has become a powerful player influencing people's actions around the globe. From fashion trends to donation campaigns, media entertainment has the power to captivate, move and connect with audiences throughout space and time. One of the oldest forms in which media entertainment has been relating with its market is through the distribution of stories in various forms. Particularly, the drama genre has enraptured audiences by its most relatable embodiment: soap operas.

Soap operas transcend cultural and geographical barriers. This attribute is based on the way they present "interpersonal situations and melodramatic or sentimental treatment" [48]. Furthermore, their realistic nature has made this genre easy to be embraced by spectators, making one if the subgenres a phenomenon worldwide: *telenovelas*. Telenovelas are characterized by the fact that they run for a limited time and are mostly broadcasted through television. These shows have long been produced in Latin America [23], a region that includes a majority of both low and middle-income nations where despair is not uncommon [28]. Countries like Mexico, Brazil, Argentina and Venezuela have a long history of producing this type of melodramas. Colombia, Peru and Chile have followed up in the race to conquer primetime in homes around the world. In spite of having Spanish as the de facto language, Medina & Barrón [23] mention that telenovelas have reached very different scenarios and become popular in nations such as Russia, Greece, Philippines and Ghana. Evidence shows that human struggle can very well be identified and understood despite cultural discrepancies [49] [50] [51].

Not only do telenovelas provide arresting content but also a safe space where parasocial relationships –those where the viewer perceives a relationship without correspondence [16]- can be developed [6]. Relating with characters does not require for audiences to change who they are but only to invest time in attending the stories of fascinating figures.

To describe the dynamics, Spence quotes R. Rosen by saying: "Viewers care at least as much about soap opera characters as about people they know" [6]. On a similar path, Tukachinsky & Tokunaga [17] explain how parasocial relationships and empathic responses are characteristic forms of involvement with entertainment media. Moreover, they develop the notion of empathy in viewers and state that it "involves the mental simulation of character's state and a link between one's self-concept and self-concept of the character." Mental and emotional components are also mentioned by Prof. Suzanne Keen in her work regarding narrative empathy. For Keen, these components are vital in the process of empathizing with characters and placing these icons in the situation being described [7]. In like manner, Peters et al. support the notion of attention and emotional involvement as the building blocks of engagement [11]. It can be concluded that fictional characters may not only be seen as entertainment but that they also nourish different elements of involvement, which complements the appeal of telenovelas.

Telenovelas present themselves as spaces where characters overcome problems familiar to the audience. Similar to a sandbox, telenovelas may be used by the audience to experience a desirable alternate reality. Louise Spence uses H. Herzog's concept of soap operas to depict them as instruments for people and as "opportunities for wishful thinking… (filling) in the gaps in their own lives… (compensating) for their own failures" [6]. Hopes and desires to be in a better situation lead to transformations on how the viewer recognizes him or herself as well as the story [24]. The soap operas that provide the idea of a promising and achievable future are identified as *pro-development telenovelas.* These are defined as a "melodramatic serial that is broadcast in order to entertain and convey subtly an educational theme to promote development" [24].

Pro-development telenovelas have a trajectory which can be traced back to the 1970's. In this decade, Miguel Sabido emerged as a pioneer for these shows. As the former vice-president of Televisa -the biggest TV network in Mexico-, Sabido developed a set of productions in which entertainment and education were combined into a profitable product for a massive audience. This model, "The Sabido model", excelled globally as countries outside Latin America adopted his technique to address issues in their own communities [32]. Based on Albert Bandura's social cognitive theory [52] regarding role models and emulation of behavior, the "Sabido model" has been applied by international non-profit organizations. Examples of these institutions are the Population Communications International (PCI) [53] and the Population Media Center (PMC) [54]. These organizations have helped spread messages related to subjects considered taboo in countries where soap operas are well accepted. Topics related to human rights and healthcare have seen major breakthroughs on being assimilated by the public.

Therefore, this work presents the possibility of establishing a link between healthcare for noncommunicable disease patients and media & entertainment in the form of smart storytelling using soap operas (telenovelas).

1.2 Research goals and questions

The main purpose for this work is to investigate the effects of interactive soap operas controlled by NCD (noncommunicable disease) patients and their blood pressure and glucose measurements. More specifically, a user group from a developing country (i.e. Mexico) has been selected due to the important role of media entertainment and the evident outbreak of diabetes and cardiovascular diseases. The motivation of this work is to help enhance the engagement concerning decisions that affect people's health. In this context, the concept of *engagement* defined by Lee et al. [44] is deconstructed to appoint two of its dimensions: interest and involvement. Besides engagement, this research will focus on evaluating the satisfaction dimension of usability.

The research questions to be answered are:

1. *How is smart storytelling experienced by NCD patients?*
2. *Which dimensions of engagement are stimulated by smart storytelling and how?*

Both questions have an exploratory nature. The first question addresses the positioning of smart storytelling within a patient's health rituals. As noncommunicable diseases require constant monitoring, patients providing data is a prevalent activity. In response, they obtain only numerical information regarding their condition creating a monotonous interaction that may lead to a disconnection from their regimen. Thus, Chreune is meant to deliver enjoyable content in exchange for their contributions. Moreover, Chreune intends to fortify their engagement towards maintaining a state of optimal health.

The second question aims to collect concrete actions and behaviors that demonstrate the degree of engagement and satisfaction. The multidimensional nature that is embodied by well-being demands the analysis of different aspects. In this way, frequency of use is not enough to determine the impact of the system. Social involvement, perception of self in terms of autonomy and competence and reflecting upon improvements in the system are complementary aspects to be considered. This second inquiry is meant to serve as a door for further development using the knowledge obtained.

1.3 Outline of thesis work

Related work is presented first to acknowledge breakthroughs. This part is divided in three sections which focus on engagement, interactive storytelling and pro-development

soap opera studies. Afterwards, the conceptualization and deployment of Chreune are explained followed by the user study methodology. Preceding the final section, outcomes are discussed to expose relevant findings. The last part of this work consolidates the findings and sets grounds for future work.

2. WELL-BEING AND ENGAGEMENT FUNDAMENTALS

As stated in chapter 1, the development of this project involves the consideration of different environments. Thus, to better comprehend the relationship and current progress, this section introduces insights regarding engagement in two categories -patient health and narrative- preceded by motivation and well-being.

2.1 Motivation and autonomy

It has been stated that (potential) patients' actions can halt the advancement of harmful conditions. Efforts have been steering the empowerment of the population to embrace change. This incitement to act is defined as *motivation* [29].

Deci & Ryan classify, in their "Self-Determination Theory" (SDT) framework, different kinds of needs and motivations of human beings. Relatedness, autonomy and competence are the three types of needs which Deci & Ryan declare as goals to be achieved. The first component, relatedness, refers to the capacity of establishing a relationship. The second one, autonomy, alludes to the freedom of choice of an individual. Lastly, competence is used to describe the amount of skills mastered to complete the tasks to achieve the goal. Meanwhile, motivation is described as the driving force behinds the actions executed to fulfill these needs. In their framework, three basic categories for motivation are proposed: amotivation (lack of motivation), controlled and autonomous.

Whereas controlled motivation relies on *extrinsic rewards* (e.g. money, compliments) to be triggered, autonomous motivation emerges from *intrinsic rewards* that pursue growth and accomplishments the individual has set on its own [30]. Studies have shown that activities driven by autonomous motivation have a substantial impact in overall outcomes. For example, the work done by Williams, Lynch & Glasgow proved that increased perception of autonomy helped diabetic patients feel more competent and adopt long-term behaviors that eventually ended in: decreased levels of distress, lessened depressive symptoms and improved serum ratios [55]. Similarly, research from Zoffmann & Lauritzen [56] and Raaijmakers et al. [57] gleaned kindred findings. Concomitantly, extrinsic rewards prove to be helpful, yet Lennon et al. point out that their effects fade rapidly once reinforcements are discontinued [58]. Ultimately, the two types of rewards set the ground for the well-being dichotomy composed by hedonic and eudaimonic elements which are explained in the next section.

2.2 Well-being: Hedonic & Eudaimonic

Hedonic well-being lies its focus on pleasure, which is defined by Kahneman as "a positive experienced state that we seek and that we try to maintain or enhance" [14]. Wirth et al. explain how hedonic well-being targets short-term satisfaction or goals as opposed to eudaimonic, which concerns the process, "a way of life" [15]. Prompt satisfaction evokes pleasure, and this has been appointed as an indicator of good health by humans since ancient times. One of the first historical references is that of Aristippus, pupil of Socrates. Aristippus was known for defying his mentor by embracing an ideology of easy and delightful living as opposed to an existence guided by virtue along with self-control [59]. Nevertheless, Aristippus did not see pleasure as an end, since this would have implied being in painful situations when the end was not met. Instead, the power and freedom to choose a more enjoyable option was considered by him as an intrinsic good itself. Afterwards, Epicurus extended the hedonic doctrine by stipulating pleasure as the absence of any kind of pain or mental distress [60]. In this sense, gratifications were a way to improve moments in a life that required aids to help achieve happiness and 'feel well'. Hellenic philosophers, however, agreed that moderation was key in balancing life as overindulgent behaviors would lead to misery.

At the same time, Socrates' postulation of truth and virtue as life goals moved forward through the works of Plato. Consequently, Aristotle -Plato's distinguished disciple- developed the concept of *eudaimonia* or "living well". Aristotle mentioned that happiness was not life's ultimate target but a consequence of virtuous activities. These conscious activities conform the never-ending quest towards achieving a higher good which would itself be desired above anything else in a person's existence [61]. *Eudaimonic well-being* can then be established as the state of holistic balance in which the person's long-term goals serve as guidelines for physical, emotional, rational and spiritual efforts.

Over the course of history, both aspects of well-being permeated societies at different levels. The hedonic facet most likely triumphed due to pragmatic ideals. An absence of pain or failure might have been considered the only sign of success. Moreover, lifestyles gradually preferred processes that would deliver faster and more effective results regardless of the method. From invasions leading to massive extractions of goods to replacing machines for workers in factories, efficiency overtook satisfaction up until the end of the industrial revolution. Once instruments started lessening the burden of achieving perfection, people became more receptive of tenets revolving around more than mere tangible objectives. An Information era brought new insights on the importance of knowledge. As technological coverage expands, so do the ideas that permeate our minds. The focus on handling information gave birth to concerns in cognitive effects. More recently, it has been observed that information and knowledge affect more than just our minds.

Calvo & Peters [4] introduced the concept of *positive computing* as part of a movement detonated by technology's impact in lives. Defined as "the design and development of technology to support psychological well-being and human potential", positive computing attempts to steer attention back to human flourishing as opposed to human rapture. In their research, both authors distinguish between hedonic and eudaimonic well-being and the repercussions that manifest in the body. Studies that corroborate this theory are those from Telzer et al. [61] and Fredrickson et al. [62], which have confirmed physiological transformations in the brain that differ from hedonic to eudaimonic stimulations.

Even though stimulations may address intrinsic motivations, Calvo & Peters include Greene & Lepper's remarks [5] pointing out that wrong implementations can lead to a loss of interest in the subject. Vansteenkiste et al. [5] complement this by stating that not all intrinsic motivations will culminate in success; more specifically, long-term success [5]. Nevertheless, intrinsic motivations have a higher chance than extrinsic ones to entice, prevail and deliver authentic satisfaction to people throughout their lifespan.

The enduring characteristic of intrinsic motivators -fomented by eudaimonic well-being practices- finds a match in noncommunicable disease prevention, control and treatment. Additionally, the non-contagious and prevailing traits in NCDs confer patients with a higher degree of responsibility as their well-being depends entirely on their own choices. Studies performed by Nunes et al [10] set the goal of NCD care as that of promoting "independence and quality of life as long as possible". As a result, autonomy plays a key role in routines carried by patients in their lifetimes. Decisions and time investment are fundamental pieces of what is considered as *engagement*.

2.3 Engagement

As established in chapter 1*, engagement* shall be defined as the combination of interest and involvement towards a specific matter. In this case, NCD treatments demand additional attention which is costly in an age of information overload. Nevertheless, those patients with knowledge of their disease and regimen are bound to develop engagement bonds with different magnitudes and aspects. Such aspects, for the purpose of Chreune, shall be defined as those related to patient and narrative engagement. Both categories are explained subsequently.

2.3.1 Patient Engagement

Patient engagement has experienced a growth of interest in the last lustrum. A manifestation of this phenomenon can be observed in the generation of international events such as: The World Congress Patient Engagement and Experience Summit, the Patient En-

gagement Summit, MedCity ENGAGE, The Patient Engagement, Education and Adherence Summit, The Health Care Consumer Engagement Congress, etc. As the number of proceedings and research work increases, it becomes clear that the interest in the topic follows. This condition makes it suitable to be considered in upcoming designs of systems that intend to have aid people in a medical condition.

One of the latest works on patient engagement is that of Barello et al. [27], who defined it as a "process-like and multi-dimensional experience, resulting from the conjoint cognitive (think), emotional (feel), and conative (act) enactment of individuals toward their health management." This perception considers a holistic view. Further analysis by Barello & Graffigna [13] displays the stages of engagement through a **Patient Health Engagement model** (PHE).

The PHE model (Figure 1) depicts Barello & Graffigna's vision of how patients with chronic diseases evolve in terms of engagement with their treatments and relationship with the staff who supports them. There are four phases –or "experiential positions"- recognized by Barello & Graffigna [13]. Each one belongs to one of the three prominent healthcare decision making models selected by Barello & Graffigna as an outcome of their research. The decision-making models are: *paternalistic*, *informed* and *shared decision*.

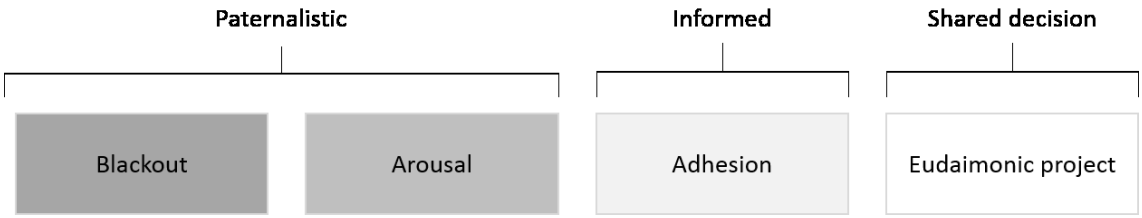


Figure 1 Patient Health Engagement Model: Decision making models & phases [26]

The *paternalistic model* encloses the blackout (fearful) and arousal (superficial awareness) phases, in which patients play a passive role without substantial knowledge of the reasons behind the decisions taken by their physician. The patients' health is entirely in the hands of the physician. However, there is already a strong and trustworthy relationship established between both parties in which assurance of care provided by an external source is key. Thus, it can be said that the relatedness need -in the Self-Determination Theory- is satisfied at the minimum in these stages.

The *informed model* includes the adhesion phase, where the patient is aware of the information available to deal with the condition (e.g. tracking of glucose levels, healthy range for measurements, diet plans, exercise routines, etc.) but fails to act adequately when the context -in which the treatment is followed- changes. For these situations, the

patient still relies on external (i.e. physician's) guidance. Moving to this phase is no longer a difficult task to achieve nowadays, as information and communication technologies have made knowledge infiltrate silently in human lives. Despite this, the level of confidence in the patient is insufficient to completely decide how to carry the treatment. This is where an opportunity for increasing autonomy and competence rises, as it will help the patient become a more confident and independent entity. The transformation of a patient from a passive element to an active one can be achieved when fulfilling all three needs.

The last model to consider is the *shared decision-making model* that comprehends the eudaimonic project (living well by considering the management of the disease as a life goal) phase. In this phase, the patient performs fully conscious decisions regarding the treatment to follow. The physician changes his/her role from a power figure to a "trusted ally". The change in dynamics affects the patient's well-being not only at a physical level but also at the cognitive and emotional ones. It is worth mentioning that a eudaimonic setting is in line with the development discussed in section 2.2 where it is mentioned how eudaimonic well-being is achieved by considering life as long-term and wholesome project.

Evidently, support is present in all stages of the model. This attribute is consistent with: the compilations from Carman et al. [68] who refer to the Patient and Family Engagement (PFE); WHO's policy brief by Coulter, Parsons & Askham [69] which declares that governments must provide information and encourage patient autonomy; and the "Multidimensional framework for Patient and Family Engagement in Health and Health Care" by Health Affairs [70]. These studies show that different actors play important roles in the patient engagement process. It must be understood that healthcare activities, while treating a noncommunicable disease, are not endeavors to be carried out in complete solitude. NCD treatments consider a team (nurses, family, dietitians, etc.) effort, yet the team should strive to make the patient as self-reliant as possible.

Overall, transitions between phases require patients to develop confidence and a sense of responsibility over their treatments. The type of changes required are not simple and patients may find useful incorporating them gradually in their lives. Chapter 1 introduced stories as means to provide people with simulations of alternate realities, where the audience can experience consequences not through their own lives but through those of fictional characters. The ethereal link created between user and story is known as *narrative engagement*.

2.3.2 Narrative engagement

Stories provide an alternate set of circumstances to which an audience can be transported in different scopes. Transportation is essentially achieved in two different dimensions per the experimental work of Bal & Veltkamp [33]. Physically, one can position him or herself in the same scenario described in the story or perceive time at the pace the story has set. Emotionally, readers can experience events in the same way as the characters or sympathize with their conditions. It is then an important matter to distinguish two key concepts in these remarks: sympathy and empathy.

Busselle & Bilandzic clearly specify that sympathy refers to "feeling emotions for characters but not sharing the same emotions" [65]. A highlight in their concept of sympathy appoints to the role of a reader as an observant rather than a participant. In this way, the reader is in a privileged position by being aware of the whole context in which the story develops. It is, in a sense, a matter of power in which readers (or viewers) obtain gratification from knowledge.

Coupled with sympathy, Bal & Veltkamp define empathy as "the cognitive and intellectual ability to recognize the emotions of other people and to emotionally respond to other people" [33]. For Suzanne Keen [7], narrative empathy explains how feelings are evoked from following stories while reading. Stories stimulate thought upon one's own life, thus helping the reader develop a narrative identity along with this introspection [67]. These feelings eliciting an emotional parallelism give the reader a choice to either continue with the state of flow or terminate the involvement by ceasing their reading activity. Choosing to follow the narrative regardless of the situation is certainly a hint that the reader is fully committed. The freedom of choice is a crucial element for stories to be genuinely embraced. Spence [6] states that spectators are classically considered as passive; however, today's digital world allows interactions between the audience and characters to cross boundaries.

Contemplating autonomy, patient and narrative engagement is a path yet to be exploited in the development of solutions for people either at risk or already enduring a chronic disease. Evidently, their relationship with the eudaimonic aspect of well-being serves as a motive to look for further applications of these interconnections.

3. INTERACTION

As humanity integrates technology in its manner of living, new kinds of interactions are required to fulfill the demands of both entities. Therefore, disciplines have flourished to understand the exceptional relationship. In this chapter, the research area of Human-Computer Interaction (HCI) is introduced, followed by the role of persuasion in interaction design. Afterwards, the notions of serious games and quantified self will be presented as derivatives of how interaction design can change the user's behavior.

3.1 Human-Computer Interaction

Improving processes is a vital part of the successful evolution of any specie. Particularly, human beings have made these transformations - in both activities and outcomes - considering effectiveness and efficiency. The latter features became standards to be fulfilled widely while propelling the creation and usage of tools to facilitate the completion of tasks. Nevertheless, devices moved forward in terms of complexity along with dialogues between operators and instruments who followed a path akin.

During the 20th century, breakthroughs in different engineering sectors produced an outburst of electronic paraphernalia. New equipment gradually reached a broader audience, demanding novel ways to interact with a greater extent of people. The evolution of interfaces is described in the compilation done by Jørgensen [72], where he distinguishes historic moments in the Human-Computer Interaction progression. From a brute beginning in ergonomics, HCI has transitioned towards a better pairing with of humans, their needs and their context (Figure 2).

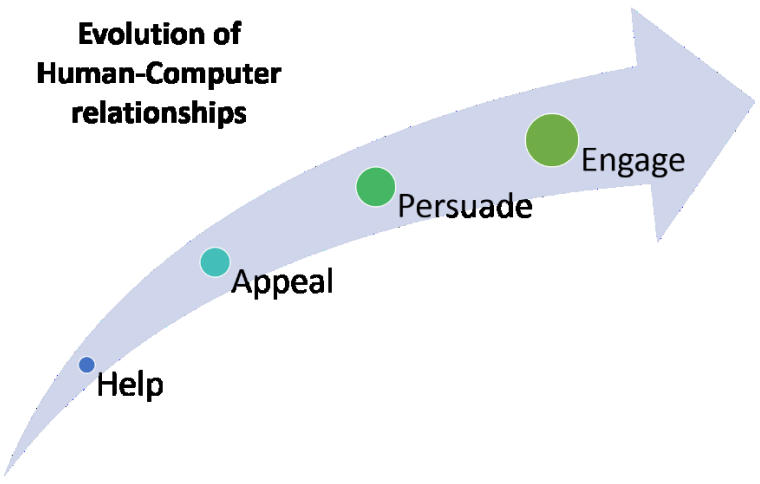


Figure 2 Stages on the evolution of Human-Computer relationships

Baecker [71] identifies six phenomena that establish fundamental milestones in HCI. The growing need to handle data more conveniently made the first major achievement the linking of data using **hypertext**. The second and third item - **interactive graphics and GUIs** - focused on resembling the tangible world. Allowing direct manipulation of computer generated graphics created a new problem addressed by the fourth milestone: **design.** From then onwards, good design became a *de facto* aspect to be considered when fabricating products.

Aesthetical and compositional changes promoted a fifth phenomenon: the objective quantification of design effects. **Usability testing** augmented the validity of incorporating human-centered design in product development. However, the insights captured during this process did not only display the impact but also the relevance of the circumstances in interactions. "I am I and my circumstance; and, if I do not save it, I do not save myself.", words of Spanish author José Ortega y Gasset, embody the last big breakthrough in HCI history. According to Baecker, making the **awareness of context** became a quintessential principle to succeed in this highly competitive period.

The prominence acquired by HCI made eminent organizations acknowledge it and preceded the nascence of others. The most notable institution in industry practices, the International Organization of Standardization (ISO), annexed a norm which considers human-system interactions. Among the concepts defined, **usability** is described as the "*extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use*" [73]. As it can be asserted, the definition incorporates the memorable transitions occurred in HCI evolution. Furthermore, the standard addresses a special aspect on the design of interactive systems: specific users, context and goals. Plenty of different scenarios involving these elements have made it viable for special associations to emerge. The Interaction Design Association (IxDA), ACM Special Interest Group on Computer-Human Interaction (SIGCHI) and the Nielsen Norman Group are examples of societies devoted to preserving and improving accomplishments in the HCI field. The multidimensional characteristic of human kind fortunately places these groups amid science and arts, where unique communication methods - for individuals and devices - continue to unfold.

Human-computer interactions establish new paths to exchange substantial information. Not only do they consider pragmatic affairs but have also evolved to embrace connotations once thought to be embodied only by human beings. As observed in Figure 2, the relationship between humans and computers seem to be developing in a similar pattern as that of human and human relationships. Thus, persuasion and engagement are the current and next phases to focus when designing the next digital tools. To seize the true potential of these tools, humans and technology ought to evolve together.

3.2 Persuasive Interaction

Human interactive systems, as Mackenzie [75] explicates, follow a closed loop model where information flows among user and machine (Figure 3). The content in this information exchange is crucial to determine the intention of the tool such as being a persuasive one. Nonetheless, the dynamics of the actors in the model remain unchanged.

It can be observed that the interface divides two sets of components used to receive and send information between user and machine.

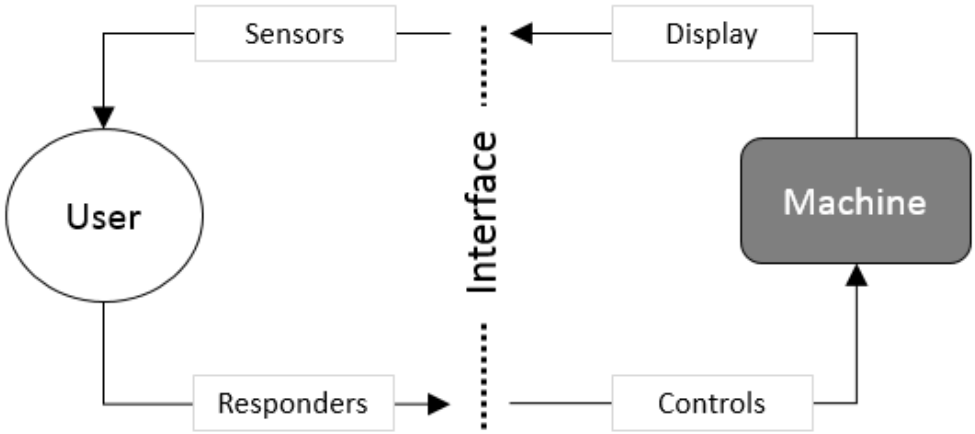


Figure 3. Human-machine interaction model based on Kantowitz & Sorkin [74] [75].

Users receive information through physiological sensors that comprise the senses (i.e. sight, audition, tactition, smell and taste). Once data is interpreted, an acknowledgement is provoked and transmitted to the machine through responders -generally involving human movement - and controls. The last part of the cycle involves the machine generating feedback based on the input from the controls and then displayed through the interface. Oh & Sundar [123] adhere the term *message interactivity* to the cycle, which refers to "the degree to which the system affords users the ability to reciprocally communicate with the system". This correspondence of messages is kept in motion due to motivations and reactions occurring in both parties. In this case, the importance this cycle has on the human psyche resides precisely in the effects caused: behaviors and attitudes.

Professor B.J. Fogg [76] presents machines as “persuasive tools” as they evoke certain social responses in the form of behaviors and attitudes. While *behavior* refers to outcomes in the form of actions, *attitude* refers to the way a user will feel and think as results of the interaction. Correspondingly, he associates these two reactions to a set of functionalities embodied by machines (Figure 4): tool, medium and social actor. As a *tool,* a machine helps users accomplish tasks more efficiently. As a *medium*, opportunities to experience scenarios are elicited by the machine. Finally, serving as a *social actor,* machines follow

social guidelines intended to build a dynamic and emotional relationship with users. This comportment generates an engagement with the machine at a level similar to that with a living entity. Moreover, these functionalities intend to couple with the complexity of human lives today.

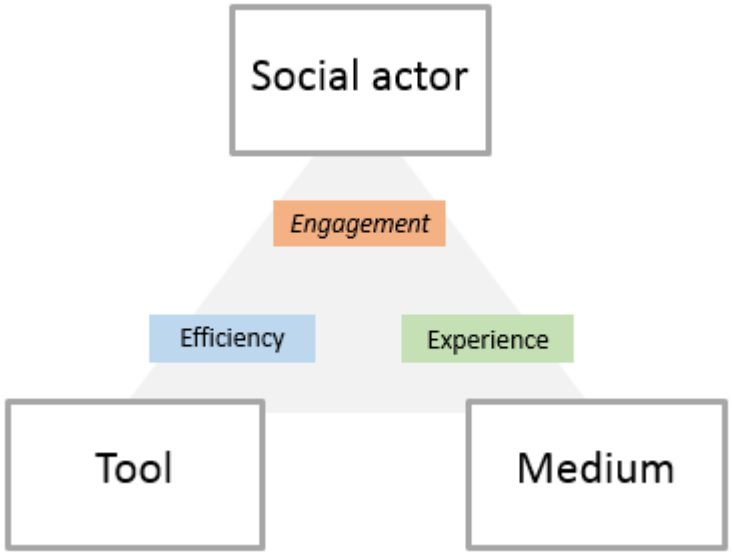


Figure 4 Functional triad of computer comparison [77].

The approach established by Fogg has become foremost in an epoch where digital developments aim towards the transformation of users. Thus, experimental research has proliferated under the branch of *captology,* the study of machines (i.e. computers) as persuasive technologies [77]. As computers have evolved, the term of *persuasive technologies* now includes all gadgets with which humans can interact and that will influence their behavior and thoughts. This versatility presented to opportunity for diverse experiments to be carried out.

A couple of examples illustrating pragmatic work on the subject are: the longitudinal study using a digital activity tracker (i.e. 'Habito') by E. Karapanos [78], ambient mirrors with different projections to encourage healthy habits by Nakajima & Lehdonvirta [80], virtual reality simulations on smoke effects by Chittaro & Zangrando [81] and encouragement for local consumption through 'BARTER' by Knowles at al [82]. These trials demonstrate that persuasive principles can adapt to assorted implementations. However, because of the rhetorical nature, captology is prone to be criticized due to the involvement of ethical matters as it reaches more areas of experimentation.

Controversial cases have recently occurred, such as that of OkCupid's manipulation of profile data [84] and Facebook's emotional contagion analysis in users' feeds [79] [83].

Despite being vulnerable to malversation, the community of scientists supporting captology has emphasized the importance of an ethical framework to abide by. Furthermore, Berdichevsky & Neuenschwander [85] and Friedman [87] have created protocols which advocate for positive persuasive design. Conspicuously, their conceptions include the preservation of a salient element: *user autonomy*. Converting users to agents with a freedom and willingness to choose is imperative in the design of persuasive technology in spite of their 'controlling' undertone.

People and societies have strived to modify how people think, feel and act. Under the term *triad of influence***, coercion** and **inducements** -along with **persuasion**- have been widely utilized to achieve objectives [88]. Unfortunately, many shrewd situations involving these techniques have appended heinous connotations to the triad and discredited persuasive techniques. Traditionally, their usage has been featured in precarious manipulations of individuals, groups and masses. Armies evicting villagers, corruption scandals and even parents pressuring their offspring to behave properly are examples of distressing practices of the triad. Nonetheless, influence on sensitive situations has also proven to be favorable. Such is the case of avoiding famine suffering by refocusing attention of habitants [89] or helping activists fight climate change by collecting signatures online [90]. These last examples are akin to persuasion rather than coercion or inducements. Whereas the latter two are mostly grounded on extrinsic factors, persuasion targets intrinsic motivators to thrive such as sympathy, peacefulness and fun.

As discussed in chapter 2, people become active when intrinsic and extrinsic motivations materialize. The Fogg Behavior Model (FMB) [91] interprets this dynamic scenario as a junction of **motivations**, **ability** and **triggers**. In line with Ryan & Deci's SDT (Self-Determination Theory) [3], FBM complements their theory including *triggers* as temporal enactive traits that must be noticeable, relatable and well-timed. These tokens serve as *signifiers* [92], reminding users of the opportunity to achieve satisfaction by using their skills. Triggers themselves capture attention in various ways and unmistakable examples of this enticement can be observed in popular and enjoyable commodities denominated as **games**.

Technology now provides the opportunity to mold more thoroughly the type of interactions between humans and devices. Moreover, being able to properly implement persuasive elements in these fabricated - yet customized - dialogs can help steer the user's train of thought.

3.3 Serious Games

A plethora of efforts towards making interactive systems as fun as games has created the world of gamification. A common misconception occurs when discussing games and

gamification. Games, as Richter et al. [93] clarify, serve mainly for entertainment. Alternatively, **gamification** is defined by Deterding et al. [20], as "the use of game design elements in non-game contexts". In between games and gamification, *serious games* expose a path where playfulness leads to the solution of real-life problems [20].

McGonigal's [94] work on serious games showcases the possibility of being transported to truly enthralling scenarios. Previously, this capacity to transport was mentioned as part of narrative engagement. Keen [18] recalls Victor Nell's remarks on readers' immersion as an "entrancement and a variety of flow". A more eloquent explanation of this state is exposed by psychologist Michael Csikszentmihalyi [19], who interprets **flow** as "the sense of effortless actions they (people) feel in moments that stand out as the best in their lives". He also gives the name of **flow activities** to those actions that grab the participant's attention, provide feedback and include the usage of the participant's skills to reach goals. As it can be observed, these understandings coincide with FBM (i.e. the conjunction of trigger, motivation & ability) and grant serious games a persuasive aptitude.

Persuasive systems, as indicated in the previous section, attain the preservation of autonomy in the player. The progress of any game demands players to perform choices continuously, thus demanding attention from the user to steer the game's course. Salen & Zimmerman [95] accentuate how meaningful play experiences include meaningful and thoughtful choices. However, Salen & Zimmerman also discuss choices included in the design of the system and choices added to the system once designed. The first ones serve as a guidance for the player, becoming meaningful only when paired with rules. Rules serve as standards and inform the player of the mechanics of the system. Hence, the player must make choices following the guidelines to achieve a goal set. The second view on the implementation of choices does not consider the repercussions on the system, but rather the attempts to grasp attention from the player for the sake of perpetuating rapture. Salen & Zimmerman declare that this type of choices forbids true interaction with the user. Moreover, Mitgutsch & Alvarado [96] elaborate on this quandary by expressing that the purpose of serious games "needs to be considered in all design components" to provide a cohesive system.

Although preserving autonomy and having a global perspective endows serious games with desired features, it is the ability to fulfill their purpose what makes these games succeed. Particularly, serious games have found a niche in education. Solutions such as *Microsoft's Flight Simulator* [98], *Mercer City Sales* (Figure 5) [99], *Pressurized Heavy Water Reactor (PHWR)* [100] and *DragonBox Algebra* [101] are examples released to enhance certain skills. By learning through simulations, players prepare themselves to confront similar problems in real life. Nonetheless, difficulties of a different nature can also be handled by serious games. *Darfur is dying* [102], *Longstory* [103] and *FatWorld* (Figure 6) [104] place attention in consciousness affairs. These titles appeal to the growth

of intrinsic motivations and, primarily, the conversion of mindsets regarding social problematics.

Figure 5 Mercer City Sales by Designing Digitally [99]

Figure 6 Fatworld Character Editor [104]

For the most part, serious games deal with subjects in appropriate ways. On the negative side, as any other projects, serious games are susceptible to flaws. *Slave trade*, a game

that teaches about the history of slavery, was severely criticized for its inclusion of a 'slave tetris' challenge [105]. Meanwhile, *SPENT* (Figure 7) [107] and *Faith Fighter* [108] are used by Macklin [106] as samples of failures due to misunderstanding of context and idiosyncrasies. While *Faith Fighter* -not precisely a serious game- inflamed religious groups who did not embrace the satire portrayed [109], *SPENT* achieved the opposite purpose of its design by diminishing empathy with the poor. These examples show why neglecting the context and overlooking possible experience journeys in game design may pose a threat to fulfilling their mission.

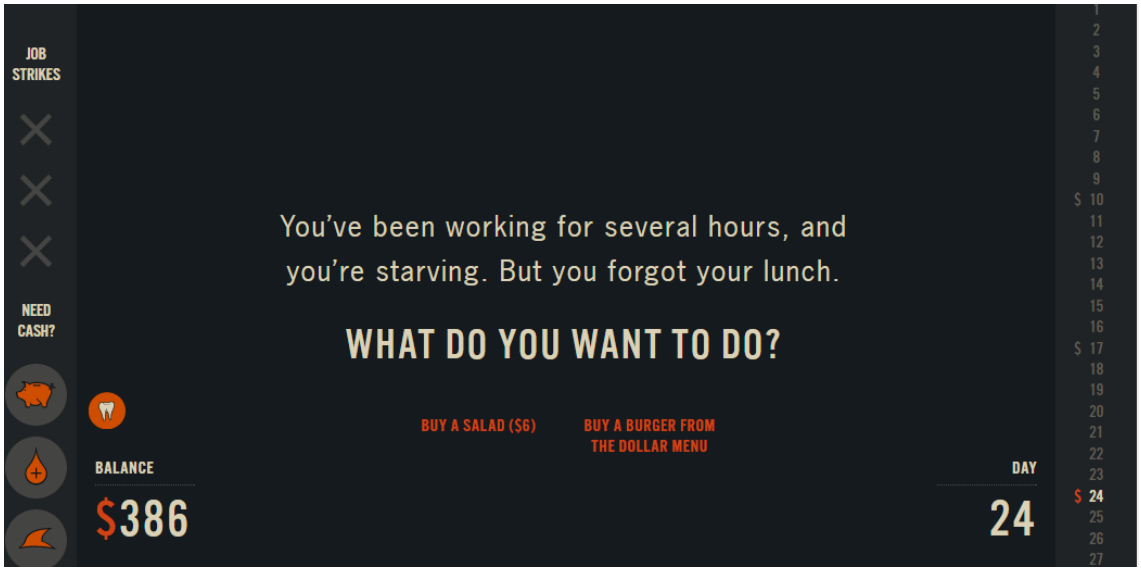


Figure 7 SPENT game. A choice must be made each 'day' to survive until the end of the month [107]

Game impact studies have shown the outreach of these kinds of inventions in different areas of human development. Trials among players have surfaced revolving around attention [113][114][119], cognition [114][115][116][117] and social behavior [111][112][118]. For serious games, cognitive repercussions have positioned 'learning' in a high-priority position to exploit the attractiveness withheld by ludic applications. Novotney [120] recapitulates the conclusions of nearly 40 studies supporting the advantages of games used to teach subjects where memory skills are decisive. Likewise, Connolly et al. [121] promote this conclusion by indicating 'knowledge acquisition/content understanding' as the most persistent topic in outcomes of game usage. Whereas motivational and affectionate game types are typically associated with pure entertainment [121], serious games adopt growth-promoting characteristics as well.

Game designers and organizations have realized the potential to strengthen dimensions of not only cognitive but also *emotional intelligence*. Daniel Goleman [122] explains this last term as a concentration of skills related to social behavior and self-awareness. As such, emotional intelligence can also be enhanced with proper practice. Developments in

interpersonal skills have been observed according to Greitemeyer & Osswald [110], who identify the increment of prosocial behaviors after interacting with prosocial games. Other examples include experiments by Peng et al. [124] and the impact on willingness to help; Bachen et al. [125] and the rise on global empathy; and Eymard et al. [126] disclosing the evaluation of empathy after interacting with *Take a walk in my shoes*. Certainly, intrapersonal skills in interactive systems have drawn more attention as user-centered design steers towards a more holistic view of human lives.

Motivation, self-awareness and self-regulation sustain the proliferation of systems dedicated to intervening in a person's life. As stated by Maslow [128], life is a never-ending fulfilment of categorized needs. Those belonging to the most essential level are physiological needs. Therefore, and because of preservation of a satisfying life, healthcare-related digital solutions situate among the leading ones on the market of persuasive technologies. Nevertheless, this trend has found its own path diverging from serious games. While serious games combine persuasive elements to reach life goals in a safe and gratifying way, real-time real-life elements to promote a greater appropriation of outcomes gave birth to the notion of the quantified self.

3.4 Quantified Self

As discussed in chapters 1 & 2, bestowing people with the responsibility of their own health requires stimulation of motivation and engagement. Most of the interactive systems designed for this purpose use monitoring as the primary instrument [132]. Under this premise, the *Quantified Self* (QS) movement has prospered because of the ubiquity of data-collecting devices [135]. Interactive systems have been created revolving around the acquisition and analysis of the information retrieved. Examples of these systems are: *Diabetes Connect* [129] and *Nightscout* (Figure 8) [176] [177], which rely on constant glucose readings from patients; the *LoseIt* program that requires users to input the food items in to determine weight-loss progress [131]; *Houston*, a mobile application that counts steps [132]; and the mental health monitor developed by the University of British Columbia, *MoodFX* [133]. Results demonstrate that frequent tracking of information proves to be effective in terms of user engagement. Nonetheless, weaknesses in this approach are not imponderable.

Figure 8 Nightscout project. An open-source platform that allows diabetes patients to monitor their glucose levels. [178]

Despite the effectiveness of 'quantified self' implementations, the study conducted by Fausset et al. [134] indicates that information is not sufficient for people to adopt new behaviors. Similarly, Choe et al. [135] enumerate obstacles such as data interpretation, misunderstanding of context and excessive amount of data being collected. Finally, Appelboom et al. [136] coincide in the fact that presenting findings in a comprehensible way is genuinely a challenge for the 'quantified self' movement. Fortunately, this movement is adopting a perspective more focused on adapting data to the people in need for their guidance.

Integrating QS practices to the holistic design of serious games adds a greater element of self-awareness. Furthermore, this combination may increase the credibility of systems and promote a deeper level of self-reflection through amusing interactions. Generally speaking, serious games supported with data may help people make sense of their own life stories.

4. INTERACTIVE STORYTELLING

It is human nature, as Gottschall [96] claims, to embrace stories as much as we embrace our own lives. Lives are stories assembled by an infinite amount of choices; each carrying a set of consequences. However, not only real lives are susceptible to effects. This chapter will introduce the usage of narrative to depict evolving information, followed by the concept of storytelling in digital environments. To finalize this chapter, interactive storytelling projects will be discussed as to illustrate the expansion of this technique.

4.1 Narrative Visualization

In chapter 3, human-computer interactions were reviewed in terms of meaningful consequences affecting the mentality of users. It was suggested that, for ideas to penetrate, the content should be recognizable and assimilated delightfully. Systems that present data (i.e. those envisioned by the 'quantified self' movement) and those that provide data to play with (i.e. serious games) have converged in the usage of narrative to improve comprehension of the thematic.

Information visualization, as described by Ware [137], has evolved from a mere "graphical representation of data" (Figure 9) to a tool for rational decision making. From his point of view, visualizations concentrate on stimulating cognitive and visual processing. However, these means have also followed the path delineated in Figure 2 (see Section 3.1) and gradually involved emotional processing. One interesting line that has followed this model is that of **narrative visualization**, a concept discussed by Segel & Heer [138], where information revolves around a specific situation (i.e. scenario) and evolves in a diegetic space & time. This invites audiences to devote more attention with the purpose of comprehending the "bigger picture" and gaining insights as opposed to only facts [144]. Examples of visualizations that use this approach are drone attacks in Pakistan in *Out of Sight, Out of Mind* (Figure 10) [145] and the effects of excessive use of antibiotics on "Why infectious bacteria are winning" [146] among others. Stories in these compositions demonstrate the remarks assembled by Waisberg [147], who identifies benefits of using storytelling to highlight the meaningful data by impinging both cognition and emotion.

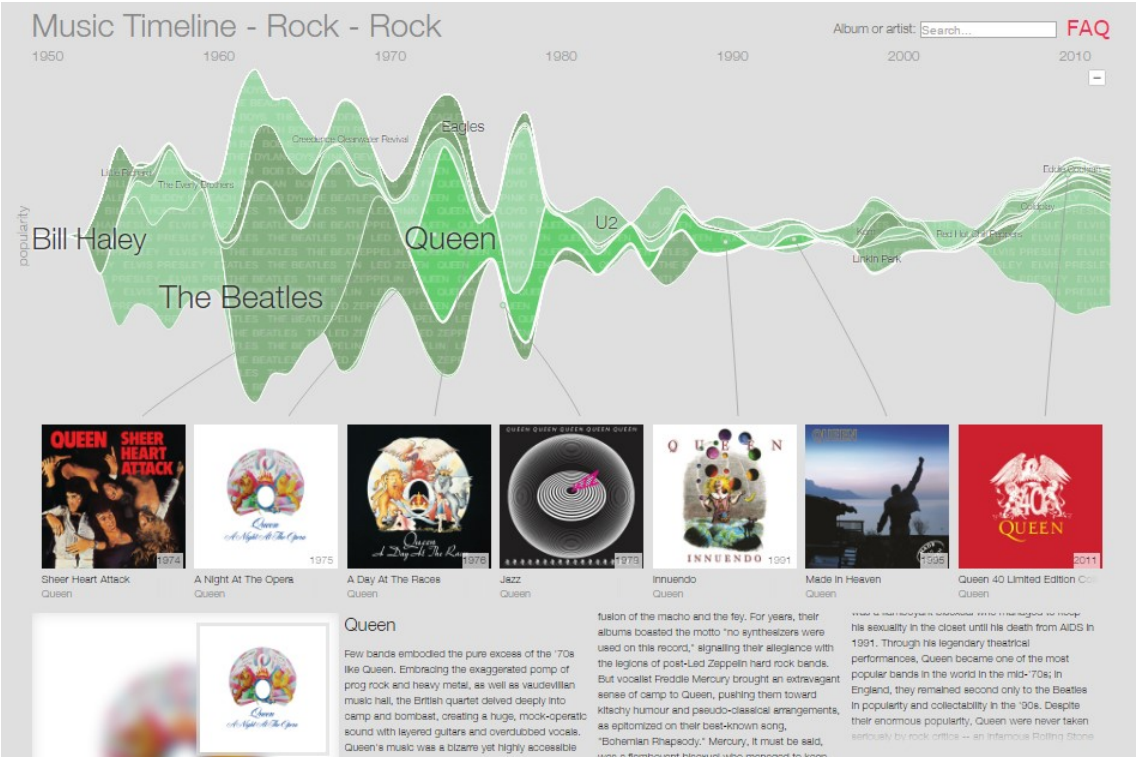


Figure 9 Example of visualization to represent data. "Music Timeline" by Big Picture and Music Intelligence at Google Research [142][143]

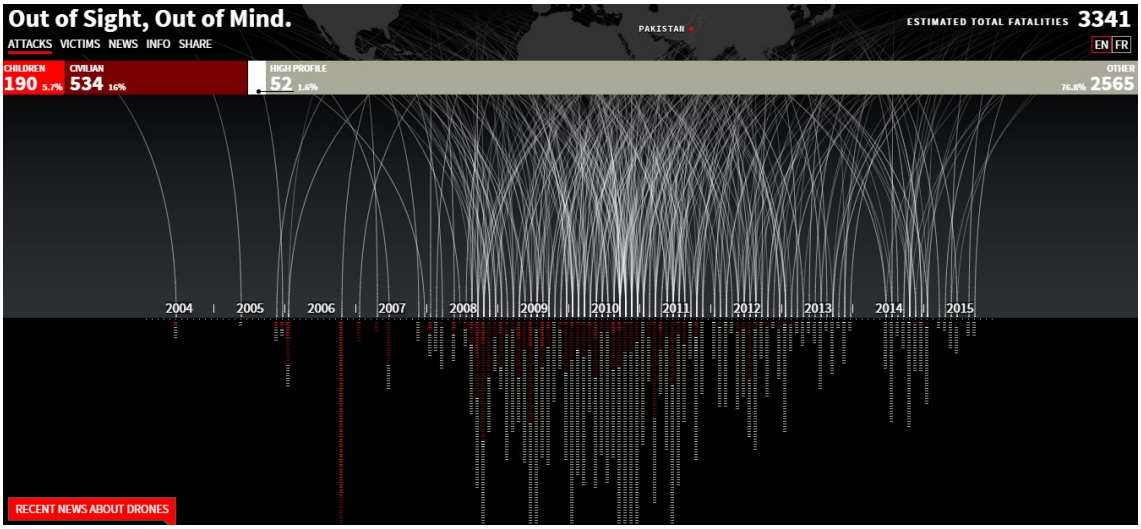


Figure 10 Out of Sight, Out of Mind shows the information regarding attacks perpetrated in Pakistani cities since 2004 [145]

The awareness of emotion as a direct influence on cognitive processes is supported across different fields. Research of these subjects has been conducted in neuroscience and psychology departments by scholars such as Profr. Elizabeth Phelps [139] at NYU, psychologist J.A. Gray [140] and Bower et al. [141] at Stanford. In addition, salient work on this

matter is that of Richard S. Lazarus [149], who sustains the idea of an undeniable coexistence and interrelationship of cognition and emotion. These studies have shown that a proper emotional factor can cause a unique and profound assimilation of content and vice versa. Consequently, implementations of these insights have been used in sectors such as: “marketing” as mentioned by Bagozzi et al. [148]; “education” as investigated by Blair [150] and Immordino-Yang & Damasio [151]; and “arts” as acknowledged by Oatley [152] and Krumhansl [152]. Along these lines, it is not a surprise to find the irruption of motivation as a latent component. As reviewed in chapter 2, a concentration of mental and emotional efforts derives in actions.

Overall, visualizations play a key role in identifying critical components responsible for the outcomes observed or desired. The recognition of the relationship between triggers and the diversity of reactions endows individuals with the faculty to choose the actions that will inevitably lead to those results. Today, interactive media assets -referred in chapter 3- provide a *sui generis* medium for the *understanding of information* and *valuation of options* processes to happen.

4.2 Storytelling and Interactive Media

In an era where information overload is common, **attention** is the ultimate good desired. A considerable amount of it is concentrated on visual signals, as this type of stimuli demands a higher degree of awareness. According to Asakawa & Takagi (as cited by Mackenzie [75]), visual indicators conform 80% of the information people are exposed to inherently requiring more cognitive processing. Nevertheless, the quality and quantity of data interpreted can be refined when implicating other modalities. Mayer [154] proposes a Cognitive Theory of Multimedia Learning (CTML), which explains how a multisensorial involvement with information helps humans create integrative mental models. Moreover, it incites users to decide which content is coherent with their previous knowledge and worthy of their consideration.

As the level of attention increases, people embark on a state of flow [19] (see Section 3.3) and become absorbed in the content presented. This situation is plausible when interest and involvement emerge from mechanisms such as storytelling.

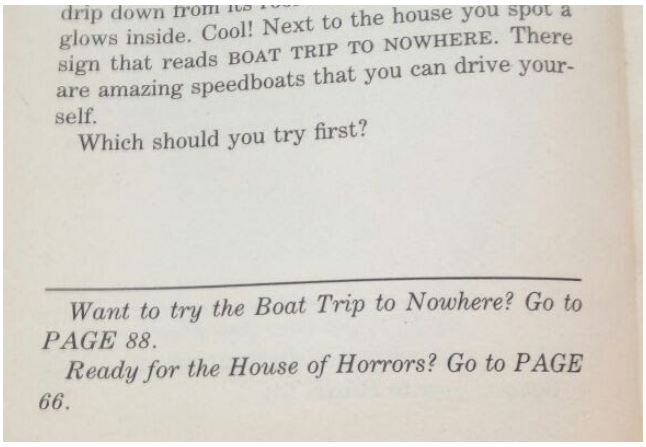
Storytelling is an activity that has suffered a metamorphosis throughout time. Earlier definitions from this act resembled that of Chesin: “telling of a story without the aid of printed page, pictures, or any properties which would break the magnetic flow between the listener and the teller” [157]. This conferred *stories* - expressions of how and why life changes [158] - an isolated and rigid role. Eventually, the gradual proliferation of media converted storytelling to "an interactive art of using words and actions to reveal the elements and images of a story while encouraging the listener's imagination"[159]. Modern

storytelling projects take advantage of the 'interactive' connotation added recently and have demonstrated the novel paths to include the audiences as conductors of stories.

4.2.1 Interactive storytelling projects

In section 2.3 it was suggested that current media developments are transforming audiences from passive to active entities when dealing with narrative. More specifically, storytellers are now using tools to promote the ownership of the story's course by readers themselves. Lebowitz & Klug [172] describe *interactive storytelling* as a spectrum composed by different levels of control conceded to users.

The first category of "truly player-driven" creations defined in the Interactive Storytelling spectrum is that of **multiple-ending stories**. These stories are distinct from traditional ones in a way that they entitle the reader with the option to choose among different endings to the story. Multiple-ending stories set the ground for **branching path stories**, which acquired more fame as media proliferated. The possibility to control different parts of the plot was a feature popularized by gamebooks during the 1980's and 1990's such as: R.L. Stine's *Goosebumps* (Figure 11) [160] Edward Packard's *Choose your own adventure* [162] and *Fighting Fantasy* by Steve Jackson and Ian Livingstone [161]. Henceforth, the writer is credited as a designer of the reading experience "but does not determine it." [96]


drip down from its
glows inside. Cool! Next to the house you spot a sign that reads BOAT TRIP TO NOWHERE. There are amazing speedboats that you can drive yourself.

Which should you try first?

Want to try the Boat Trip to Nowhere? Go to PAGE 88.

Ready for the House of Horrors? Go to PAGE 66.

Figure 11 Fragment of R.L.Stine's "Escape from the Carnival of Horrors"[171]

The conception of numerous experiences transgressed barriers, not only in narrative structure but also in the medium they had been confined to. With the explosion of information technologies, multimedia development made stories in other forms to be manipulated as well. Decisions at the bottom of pages have become buttons in interactive online videos such as *Two Billion Miles* [179], Jeff Buckley's "Just like a woman*"* [174] and DANIELS' *Possibilia* (Figure 12) [175]. These projects reside at the brink between interactive stories and games, which are considered in the last levels of the Interactive Storytelling

spectrum. Therefore, making more elements available to be manipulated may appear to force authors relinquish control over the story.

Figure 12 Possibilia: "An interactive love story set in the multiverse...whatever that means"[175]. Choices appear as clickable thumbnails under the main video.

Following Lebowitz & Klug's autonomy shifting in stories, writer & game designer Chris Crawford [173] discusses this as an issue where authors sacrifice their authorship and subjugate their ego for the 'greater good'. Meanwhile, narrative director Corey May [180] possess this struggle between control & interactions (i.e. gameplay) and story not as a competition but as a collaboration. Surprisingly, virtual reality appears to be a viable solution for maintaining the spine of the story intact while allowing users to explore more of it. Virtual reality experiences, such as *Notes on Blindness* (Figure 13) [181] and Google Spotlight's "Duet" [182], are examples of how one single story can be explored in different ways by the user. In spite of appearing as a constraint for creators, interactive storytelling incites authors to invent a space where the audience can empathize with the story and explore different points of view simultaneously.

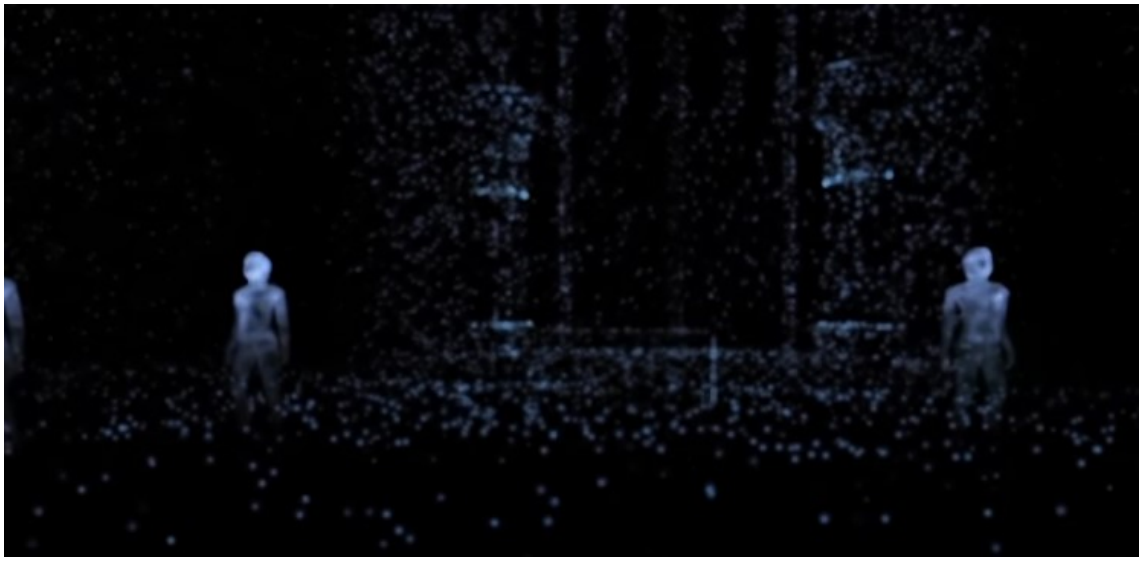


Figure 13 Notes on Blindness, a virtual reality experience that lets users explore the life story of Profr. John M. Hull [181].

At the same time, traditional visual media (e.g. television, movies, videos) has adopted the bidirectional dynamics of contemporary technologies to change the fate of stories rapidly. Online communities and social media tools allow spectators to communicate with show productions and influence on different aspects. Recent examples include deciding plot twists in the Brazilian soap opera *Geração Brasil* [184], inducing behaviors in characters for Bravo's *The Singles Project* [185], and even selecting endings for each episode in Channel 4's *Dubstep Drama* [186]. Ursu et al. [187] ascribe television the strength to develop *interactive narrativity* - "ability to interact with (and influence) stories whilst they are being told"- by pairing their know-how on storytelling with the collection of viewers' feedback using digital tools. More importantly, the impact of choices in entertainment media, traditional or recent, has acquired interest among the research community.

4.2.2 Precursory research work

Certainly, being able to control and immerse in stories has repercussions in the user. These behaviors and manifestations have been explored in different scenarios, making those related to autonomy and well-being relevant for the purpose of this work.

In chapter 3, serious games were reviewed as persuasive tools that encouraged autonomy and self-tracking. For instance, *DIAB* [127], a video game for children that promotes physical activity and consumption of food low in energetic density, requires users to choose behaviors of characters to achieve goals. This goal-oriented focus hinders evoking insights, yet usage of stories with real people uncovers this area and reinforces their effect.

When individuals are in control of realistic stories, changes in eudaimonic aspects of well-being are witnessed. Adler [188] recognized how patients at a clinic improved their sense of autonomy by documenting their own daily routines and enhanced their mental health in term. Similarly, DiFulvio et al. [189] claimed that Latino women showcasing their own life stories using digital counterparts enhanced their view on "control over future", more specifically in terms of overall health. Finally, Yin, Ling & Bickmore [190] utilized an interactive visual novel with previously-hospitalized patients and confirmed an increase in self-efficacy and empowerment. These observations uncover the possibility of using relatable interactive storylines (i.e. telenovelas) to engage and encourage autonomy in noncommunicable disease patients -such as diabetic- through habits that foster eudaimonic (holistic and balanced) well-being (Figure 14).

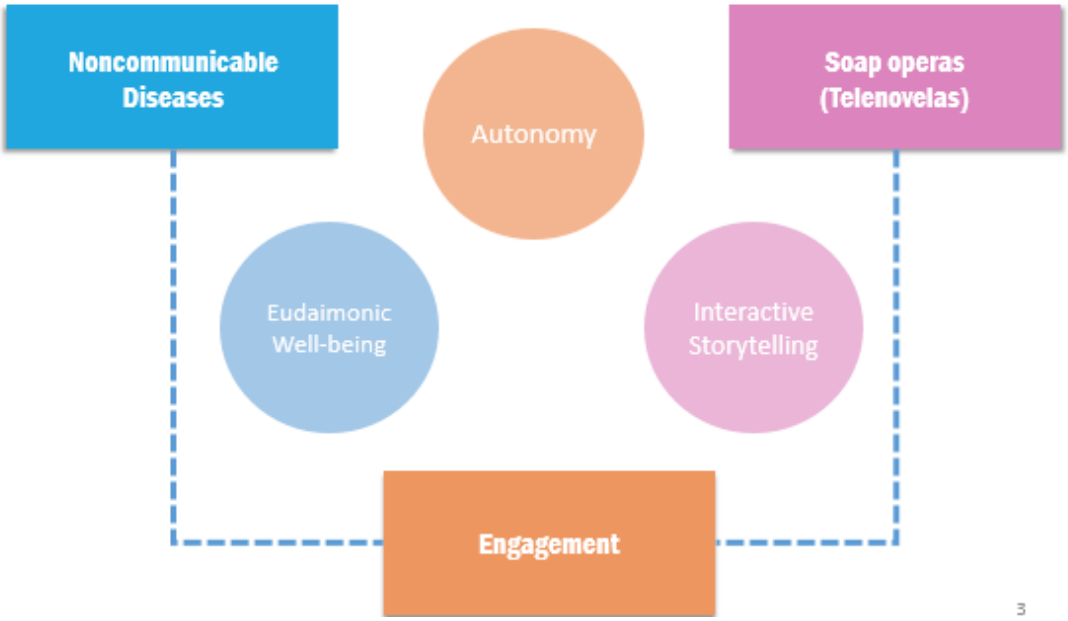


Figure 14 Convergence of noncommunicable diseases, engagement and interactive storytelling

For the most part, the treatment of noncommunicable diseases forces a habitude that relinquishes reflection. Monotony reinforces behaviors but decreases the conscious interest as actions become mechanized. It then becomes a viable option to create unusual situations that can disrupt their routine in a positive way and allow for the progression of eudaimonic well-being. Additionally, exercising their sense of autonomy -through interactive storytelling- may prove beneficial for their well-being even when not making decisions that refer directly to their health state. Thus, using relatable stories he/she can control can be an enticing activity that may target both interest and involvement from patients. Conclusively, incorporating real data in the interaction of patients and stories becomes a valuable component for patients to observe how their real-life actions can open the path to real and virtual consequences.

5. CHREUNE: SMART STORYTELLING SYSTEM PROPOSAL

This chapter explains the goal and development of Chreune, an interactive storytelling system that develops a narrative based on biological measurements of noncommunicable disease patients.

5.1 Concept

Chreune intends to be an interactive system where dynamic stories can be built using predefined blocks of narrative. Following the basic structure of interactive fiction, Chreune's stories respond to decisions made by the patient throughout checkpoints in the storyline. The decisions, however, are constrained to the valence of the biological measurement obtained from the patient. To the knowledge of this research, the project that resembles the most is Dutch videogame *GRIP* (Figure 15) [192].

Figure 15 Interface of GRIP, a serious game for young diabetic patients [191]

GRIP uses medical records of diabetic patients to question them on the reasons of the measurements registered [191]. Thus, the fate of characters in the game is determined primarily by the decisions from the player itself. Nevertheless, GRIP is aimed towards a younger demographic (i.e. children) and utilizes cartoon characters to develop the interactive narrative. Comparatively, Chreune is meant to take a similar path yet aiming adults

who can relate to the narrative of the story and simultaneously ponder about their everyday actions in real life. Furthermore, it is meant to be a serious game that fosters interest and involvement in a scenario where inertia and context hinder reflection.

5.2 Design process

The method embraced to design Chreune was Ideo's Design Thinking process [34] due to its elemental construction. This design thinking process distinguishes three stages to find a solution for problems. These stages are: inspiration, ideation and implementation (Figure 16).

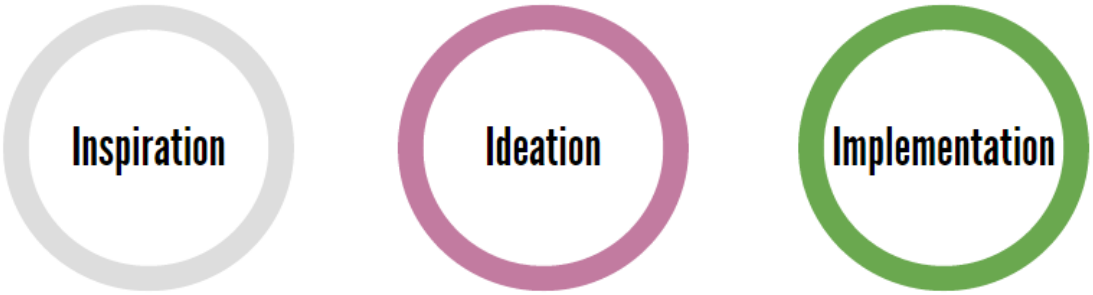


Figure 16 Ideo's Design Thinking Process

5.2.1 Inspiration and Context

The first stage, inspiration, was carried out by observing behaviors in patients with chronic diseases in Mexico. A close relationship with middle age patients (i.e. parents and family friends) encouraged the endeavor of improving their lives and made empathizing with their situation a fated task. Additionally, changes in the populations pyramids worldwide show an increase of middle-aged adults and make this sector an enticing one to design for [199]. However, pinpointing the aspects to target required a thorough understanding of the subtle dynamics driven by culture.

As a culture described in Hofstede's 6D Model [35], Mexico's high indulgence score [97] and low long-term orientation [24] may create a troublesome scenario for long-term treatments to succeed. The need for extrinsic rewards and the struggle to commit relentlessly can be associated to situations commonly observed in the Mexican scene.

Studies performed on Mexican culture's behavior deliver glimpses of how indulgence and preference for short-term activities manifest in this Latin American society. For example, the indulgent characteristic may manifest in a high demand of entertainment created by Mexican families. Mercer's study [37] depicts 'entertainment' as the fourth category in which Mexicans spend their income preceded by housing, food and education.

Additionally, in 2015, 97.5% of the households in the country were registered as having at least one television [38] thus providing a direct source of entertainment to most of the population. Although this may be true, recent studies have found that accessible entertainment is no longer coming only from traditional media. Per the GlobalWebIndex in their "Digital vs Media Consumption Report" [36], Mexican audiences devote close to 5 hours per day on traditional media (i.e. radio, television) but nearly 8 on their digital counterparts in average.

Even though audiences dedicate considerable amounts of time on audiovisual entertainment, the desire to invest part of this time in long-lasting activities is poor. This manifests in phenomena such as the demand of 'miracle products' that promise immediate results [39], illegal payments to authorities to accelerate paperwork (i.e. corruption) [40] and a high and early school desertion to earn money promptly [41]. Unfortunately, the collision of both dimensions enables the prevalence of unhealthy behaviors. Alluring sedentary entertainment and a low disposition to invest time in long-term processes promotes the prevalence of noncommunicable diseases (i.e. diabetes and heart related). Nonetheless, steering the drive behind these two tendencies may prove helpful in coping with the very same problems they sustain.

5.2.2 Ideation

Once context and components were extracted, the ideation phase focused on designing a tool for noncommunicable disease patients to embrace their long-term treatments as they would with entertainment. In chapter 2, narrative engagement was described as the outcome of a dynamic between a captivating story and an empowered audience. Certainly, the latter condition is desired for patients whose betterment depends mostly on their own actions. Therefore, the essence of Chreune relies on the implementation of storytelling to connect with people, confer power on them and provide entertainment at the same time.

In chapter 1, dramatic stories deployed in mass media were presented as a case in which behavior changes occur upon assimilation of the message conveyed. More specifically, those stories presenting human struggle and fortune (i.e. soap operas, telenovelas) were chosen due to their impact as discussed in chapter 4. However, and following the Fogg Behavior Model, an audience requires a trigger to enact upon motivation. Hence, the next element to integrate in the design was a set of elements that encourage action.

In chapter 3, interactive systems were explained as data exchange mechanisms which have evolved to become supportive and actionable ones. These characteristics make them eligible to aid in the transformation of users from passive to active. Furthermore, it became clear that a digital interactive system would potentially help foster involvement when paired with fascinating stories. Asking patients to perform small tasks in exchange

for entertainment created the spine which supported a basic interactive architecture. The trigger, in this case, would be a self-reflective task that would relate the fictitious story with their own.

Initially, the interactive flow in Chreune (Figure 17) started with a request for either a glucose or a blood pressure measurement from the patient. Afterwards, the measurement would be placed in one of two categories: good (i.e. inside a healthy threshold) or bad (i.e. outside of the healthy threshold). The positioning of the good measurement would give access for the user to discover a positive episode in the story. Contrastingly, a bad measurement would only grant access to a troublesome version of the same narrative. Upon completion of the episode, a cliff-hanger was devised to foment curiosity in the user and encourage a consecutive interactive session.

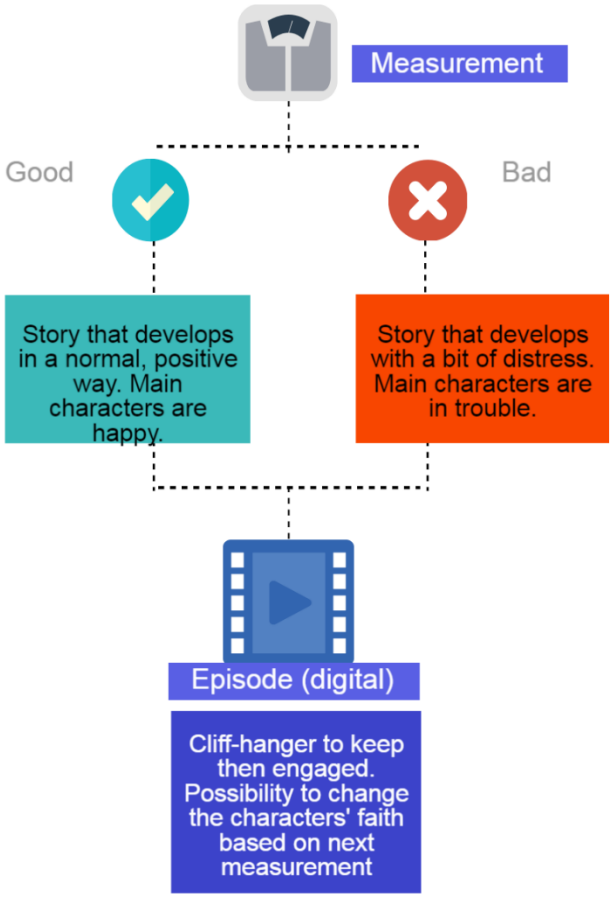


Figure 17 Basic interactive flow for Chreune

Having a clear definition of the concept and interactions provoked the development of prototypes. The first prototype of Chreune was created in paper following a fictional story

titled “Sweet Serendipity”. This story portrayed the life of Raphael, a software architect in Sydney, whose life moments have alternate versions depending on the path a spectator chose to explore. The usage of a storyboard in movable paper blocks (see Appendix A) demonstrated to be efficient in creating a map for direct manipulation in stages of digital implementation.

A second prototype was generated based on the first one. An interactive presentation was generated using Google Slides and scanned story blocks from “Sweet Serendipity”. The presentation included links on each episode (Figure 18) that allowed the user to determine the fate of Raphael on the next chapter. For this prototype, the input of the measurement was assumed to be verified by the moderator prior to the user selecting the link.

Figure 18 Interactive slide showing a story block. Two big blocks on the right represented links towards the next block. The user can choose the mood for the next story block.

Rapid evaluations of the previous prototype were conducted with peers and supervisors. From these brief sessions, a salient point of concern was the discoverability of links and how to traverse the story. The layout of the graphical elements became a special matter, as Chreune would have to face a non-tech savvy target audience known for requiring explicit visual components. This remark would not only apply to the flow of interactions but also to the flow in the story featured. Thus, the usage of static images was also questioned as it appeared to be intriguing at first but did not seem to elicit interest beyond an initial glance. Given that the concept relied on telenovelas broadcasted on television, it was proposed that moving images would draw more attention than its inert counterparts.

These issues were addressed in the design of the functional implementation, which considered standard graphical user interface (GUI) elements (i.e. buttons, text fields & video containers) to clearly show actions available and deliver an enticing experience.

5.2.3 Difficulties

During the design thinking process, minor obstacles were encountered which modified the course planned initially. The most critical ones were:

Adequacy of story

Evaluating the storyline for 'Sweet Serendipity' exposed an important feature to consider in participants. As the spine revolved around a feeble romance, technology and mostly a male figure, it was considered that the participants to be recruited - adult women - would find the plot unrelated to their lifestyles. Thus, a search for a new storyline had to be executed through online sources. This task was accomplished successfully, as content from enthralling stories in foreign countries (i.e. American soap operas/dramas) is free and available in open video streaming platforms.

Fabrication of content

The decision to create an engaging prototype with multimedia components posed two questions:

- Where to find an interesting written story?
- Which visual elements to use as means to illustrate the story?

For the first question, a search for writers and stories was conducted in social platforms such as Wattpad [42] – a platform to publish written content, mostly stories - and Twitter for two weeks. However, only one Spanish writer responded to the announcement and opted to collaborate in this project. Although the story provided was interesting, the genre (i.e. crime fiction) was not adequate for the target group because of the violent content.

The second question had been considered in the ideation phase. During this stage, thoughts about introducing only video content prevailed over written one. Conducting a modest video production was proposed to the staff at Guanajuato's Cultural Forum (http://forumcultural.guanajuato.gob.mx/). Nevertheless, the lack of a full-formed story early in the process dissipated the chances of this form coming to life. Ultimately, using an existing story (i.e. fully produced TV show) facilitated the process of deploying Chreune on time.

Ultimately, these hardships were overcome on time and, in fact, uncovered a simpler path to implement Chreune.

5.2.4 Implementation

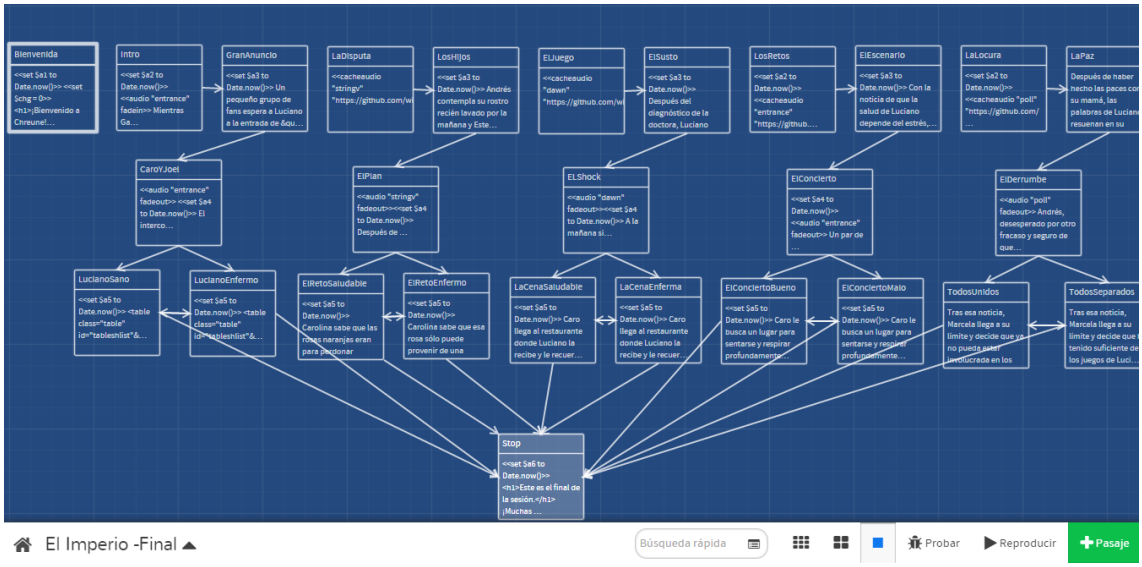
For the implementation phase, two tools were considered to create interactive stories.

The first was Inklewriter [193], a web-based platform to write stories that follow the same approach as ‘choose your own adventure’ books. The second choice was Twine, “an open-source tool for telling interactive, non-linear stories” [43]. The final tool was selected based on the features that each platform provided and how well they adjusted to the development of Chreune.

Inklewriter allowed for written passages to unfold according to the choices made by the reader. This selection process continues until the story reaches an end. However, Inklewriter offers limited options to customize the visual presentation of the story. Therefore, Inklewriter was discarded for the development of Chreune.

Contrastingly, Twine enables programming languages (i.e.HTML, CSS and Javascript) to let creators present each passage as an enhanced HTML page able to be linked to others. These links and passages are visualized in a blueprint interface hosted by Twine (Figure 19a) and are set by code within each passage. Using basic conditional statements, specific links only become active depending on a previous input of data (Figure 19b). The flexibility provided by Twine in terms of navigation, customization and media support made it suitable for the development of Chreune.

Since Twine creations are stored in files locally (i.e. in the PC), the decision to increase accesibility using a location online became primordial to test Chreune without depending on one machine. Fortunately, Philome.la -a hosting platform for Twine projects- is available for free and was used to host Chreune. The latest versions of Chreune (http://www.philome.la/winterdamsel) can be accessed through Chrome browser.



a)

```
<<if $measure > $topRange>>
      [[Final triste :( |LucianoEnfermo]]
    <</if>>
    <<if $measure <= $topRange and $measure > $lowRange >>
    <<set $open = 1>>
        <<click [[Final triste :( |LucianoEnfermo]]>><</click>> <<click [[Final feliz :) |LucianoSano]]>>><</click>>
    <</if>>
    <<if $measure <= 0 >>
       <<goto CaroYJoel>>
    <</if>>
```

b)

Figure 19 a) Blueprint of story ("El Imperio") in Twine. b) Snippet of Javascript in Chreune's Twine implementation

However, creating the content for the interactive story became an arduous task compared to the interactions. As discussed previously, adding moving images to tell a story was considered a befitting option to capture the users' attention. Currently, gratuitous video-sharing platforms (e.g. YouTube, Dailymotion, Vimeo, etc.) are used by television networks to provide footage for several of their productions. Numerous television shows upload snippets of their episodes as part of brief recapitulations to engage the audience. One of the shows that delivers online content for all their episodes is FOX's musical drama: *Empire*.

Empire was selected as the story to present primarily because video content for it is available online, allowing for the creation of videos to illustrate the story. However, additional features found to befit the conditions:

- The chances of the target population knowing the show are slim, as it is not in their native language nor was it available on open television in Mexico.
- It has been highly rated in well-known film & television rating databases such as IMDb (7.8/10) [155] and Rotten Tomatoes (83%) [156].
- The plot involves a family overcoming relationship and health problems.

Episodes from Empire's first season were translated and adapted into a compressed written form, which was broken in 25 passages (Figure 20). Each passage had multimedia components (i.e. GIF, MP3) embedded along text to permit participants set the pace of the story. More specifically, GIFs were used considering possible technical difficulties (such as slow internet connection) and the fact that dialogues in the video snippets would have been in a foreign language for the target audience. To complement the experience, music samples were given through MP3 files to set an acoustic tone for each episode.

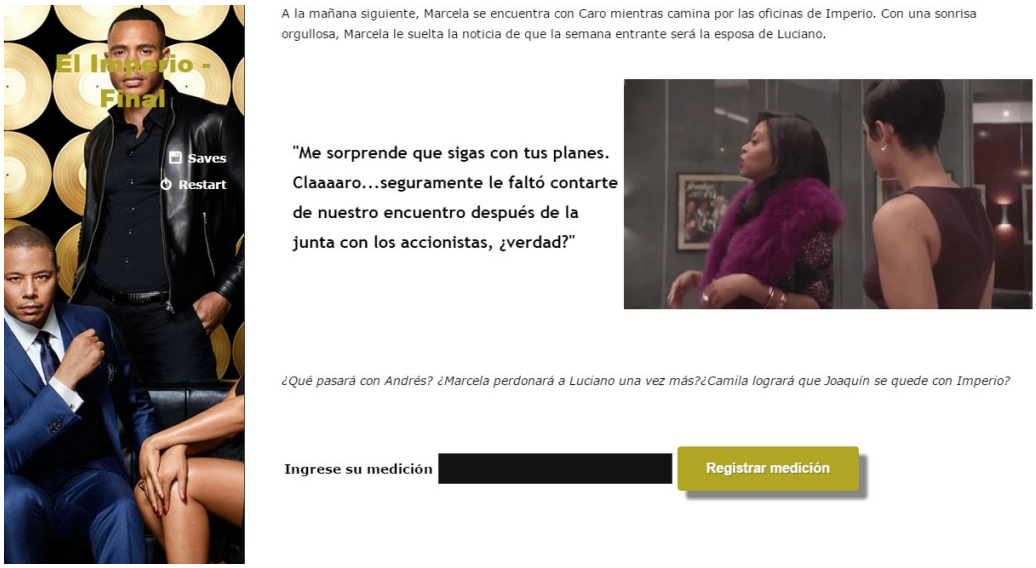


Figure 20 Chreune passage. Dialogs from characters in the scene appear in bold and next to the movable images. Upon registering their measurement, the black textfield and confirmation button vanish and the buttons that allow navigation to the next chapter appear.

Ultimately, Chreune is the product of technological elements that consider a traditional-media audience. Whereas the design and implementation seemed direct, the evaluation of Chreune posed new challenges that were overcome through next phases of exploration, selection, planning and adaptation. This process is presented in the following chapters.

6. METHODOLOGY

This chapter explains the methodology implemented to answer the questions stipulated in chapter 1. As stated in the introductory section, the research aimed to observe thoughts and reactions of NCD patients who manipulated a story based on biological parameters. Particularly, the focus shifted to women from a developing country (i.e. Mexico) due to the excessive number of NCD cases and ingrained appeal of telenovelas in their culture. Two research questions were proposed to guide the course of the observations. The first one attempts to expose how smart storytelling is perceived with NCD patients. The second one concentrates on the stimulation of dimensions of engagement. The sections that follow describe the characteristics of the participants as well as the tools and process followed for data collection.

6.1 Participants

Initially, the plan called for recruiting participants at public healthcare centers who attended periodical appointments with their physician (see Appendix B). Although agreements had been made with physicians, patients at these healthcare centers were prone to attend only once a month. This situation presented a problem, as the time span between sessions exceeded the expectations set during the design (i.e. 5 sessions per person executed in 2 weeks). To overcome this problem, the recruiting took place at a community where members met daily: the Hans Christian Andersen elementary school in the city of Pachuca, Hidalgo, Mexico. In this case, patients who were among the school personnel and parents of the alumni were invited to participate in the study through announcements during a morning and an afternoon assembly.

The invitation to participate was addressed to adult women with a noncommunicable disease (i.e. cardiovascular, diabetes). The population selected for the study was between the ages of 25 and 75 years old. The average age for participants was 55.9 years old. Additionally, participants were required to not be visually impaired and able to read and write in Spanish at a 9^{th} grade level.

A total of 14 participants were recruited throughout the whole evaluation period for Chreune. One participant (50-year-old woman) was selected for the pilot test. Ten participants were recruited at the beginning of the trial period. However, one participant was unable to continue the study after session 2 due to medical complications and was dismissed from later sessions. Afterwards, two candidates appeared to have difficulties reading the text and were discarded after the first session. Nevertheless, two more volunteers

were found promptly. One final participant had to be recruited outside of the school premises (i.e. at a pharmacy) to satisfy the participant quota.

Most participants performed jobs in attention-demanding environments (i.e. teachers at an elementary school, housewife with small children, pharmacist in the evening shift).

Most participants (7/10) were under a treatment to control a cardiovascular disease (i.e. high blood pressure). Meanwhile, type 2 diabetes patients conformed 2/10 and one additional patient was diagnosed with a pre-diabetes condition. Along with their physical condition, the state of the relationship with their treatment was identified using the PHE scale. With this rubric, the group was formed by: 2 participants in an Arousal phase (superficial awareness), 5 participants in an Adhesion phase (aware of condition and resources yet lacking full understanding), and 3 patients in a Eudaimonic project phase (embracing their condition and treatment as long-term life goals) (Figure 21). This categorization helped identify that most of the participants perceived themselves as properly informed and with control over their treatment.

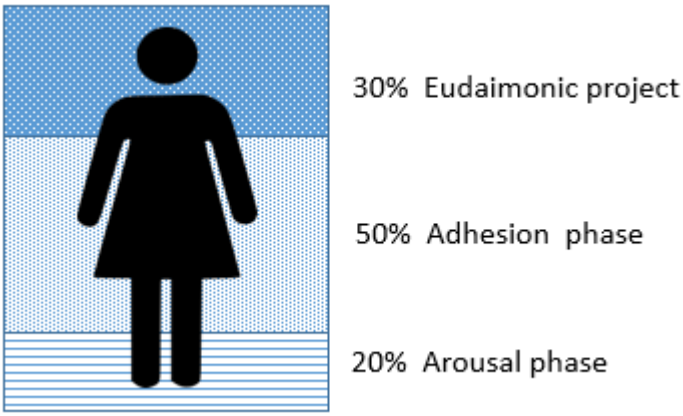


Figure 21 Percentages of participants in different PHE scale phases

Most participants acknowledged they consumed visual media but not soap operas specifically. Only one participant declared she did not watch nor enjoyed media entertainment. Participants expressed that TV shows were not important to them.

6.2 Data collection

A research plan was drafted to proceed with the evaluation of Chreune (see Appendix B) prior to conducting the study. Within the proposal, the aspects considered were: instruments (digital and research), tasks and risks.

6.2.1 Digital Instruments

For this research, the following electronic equipment was used to collect information throughout the trial period (see Table 1).

Table 1 Electronic equipment

Category	***Equipment***	***Functionality***
Medical equipment	Neutek BP-201M Blood Pressure Monitor	Obtain blood pressure measurements (see Figure 22).
	Accu-Check Active glucometer kit	Obtain glucose measurements (see Figure 22).
Hardware	Dell Inspiron N5110 with Windows 7	Deploy Chreune. Record user interactions.
	Generic earphones	Allow participants to listen to the background music if they wanted to.
Software	Icecream Screen recorder	Record user interactions. Record audio from interviews.

Figure 22 Neutek monitor (left) and Accu-Chek Active Glucometer kit (right)

6.2.2 Research Instruments

Additionally, research instruments were selected and translated to Spanish -when necessary- to retrieve insights from participants at different stages. The formal tools employed were:

- Patient Health Engagement Scale [26] (Figure 23), which revealed the patient engagement level (see Appendix E).
- Treatment Self-Regulation Questionnaire (TSRQ), that determined the "degree to which a person's motivation for the health behaviors is relatively autonomous" [163][164] (see Appendix E). The questionnaire makes a distinction between autonomous regulation and controlled regulation. These two categories englobe the regulatory styles proposed by Ryan & Deci [170]. Controlled regulation merges external and introjected styles due to their proximity to external motivations. Autonomous regulation gathers identified, integrated and intrinsic styles because of their closeness to intrinsic motivations. Lastly, a Relative Autonomous Index (RAI) is used to determine which domain -either autonomous or controlled- prevails. The results of this questionnaire were compared at the beginning and at the end of the trial period.
- Narrative Engagement questions provided insights on the emotional engagement and narrative understanding the episode presented. These were selected from the 12-item Narrative Engagement scale by Busselle & Bilandzic [65] (see Appendix H). Each statement is measured in a Likert scale that ranges from 1 to 7, going

from ‘Totally disagree’ (1-2) to ‘Neither agree nor disagree’ (3-5) and finalizing in ‘Totally agree (6-7).

- UEQ (User Experience Questionnaire) [165] was used to measure five aspects of the experience produced when interacting with a system. Even though AttrakDiff [166] is positioned as a prominent option, UEQ was chosen due to its thorough modular structure (i.e. ‘Efficiency’ aspect could be isolated as it was expected to be low due to technical constraints) and availed translation to Spanish.
- Net Promoter Score (NPS) [167] detected how likely would the concept reach acquaintances of participants. Reichheld proposes this concept to glimpse the level of loyalty from customers. Although NPS validity has been questioned by scholars such as Keiningham et al. [168] and Grisaffe [169], this tool was selected to elicit reflecting upon a user’s willingness to be engaged.
- Usability evaluation, which incorporates the usage of Nielsen Normal Heuristics for User Interface Design [194] and a classification of issues based on severity. Along with the categorization, recommendations are provided for each issue.

Figure 23 Patient Health Engagement Scale System by Graffigna et al [26]

In addition, brief semi-structured interviews were devised to find additional information regarding the context and thoughts of participants.

The relation between the instruments listed previously and the dimensions of engagement are illustrated in Table 2.

Table 2 Research instruments

	Research questions: concepts		**Dimensions of engagement**
	Experience with Chreune	*Stimulation of Engagement*	
Research Instruments	UEQ (User Experience Questionnaire)	Narrative Engagement questions	*Interest*
	Session 5: Semi-structure interview questions	Net Promoter Score	*Interest*
		Treatment Self-Regulation Questionnaire	*Involvement*

6.3 Procedure

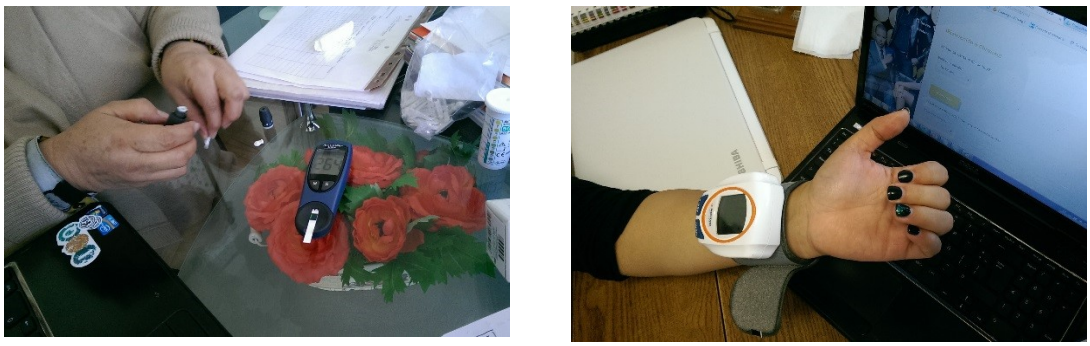
Participants were handed printed consent forms and background questionnaires prior to conducting the trial sessions. They were asked to complete the forms within a week of receiving them. Since attendance to the school premises occurred daily, participants were reminded verbally about the consent form reviewal after 2 and 5 days. Participants were also notified that reception of consent forms was open from 8:00 to 15:00 hours at the principal's office. Upon the retrieval of documents, participants were presented with the opportunity to participate in the session either in a private room located inside the premises (for those at the elementary school) or in their workplace (i.e. classroom, office or pharmacy counter). This option was presented before each session.

A within-subjects research design (i.e. all subjects were exposed to all conditions available) was implemented and each session was executed individually with each participant. A maximum of 20 minutes had been disclosed in the consent forms for each session, as this estimate had been calculated from the pilot test and it was expected for participants to be completely available for this period.

6.3.1 Session 1

In the first session, participants were asked questions regarding their treatment & lifestyle, desires and media (i.e. television shows) consumption habits (see Appendix E). Following the inquiries, participants were presented with Chreune deployed in a laptop and given a participant code along with a post-it to write it on. Afterwards, either a glucose or a blood pressure measurement was performed on the participant per the illness diagnosed

(Figure 24). Measurements were documented in the notes of each session. Finally, a set of tasks was given one at a time for participants to accomplish (Table 3).



a) **b)**

Figure 24 Obtaining measurements a) glucose and b) blood pressure

Table 3 Usability tasks

No.	Task
1	According to your day so far, choose the answer for the question “How are you feeling today?” and confirm.
2	According to your condition, choose the answer for the question “Which illness are you dealing with?”
3	The moderator has given you a participant code previously, please input your participant code.
4	The story that follows is split into 4 parts. You can access the first 3 parts freely. Now go through the story and stop once you are asked to input your measurement.
5	To unlock the 4th part, you are now being asked for your measurement. Please input your measurement to continue with the story.

Once tasks were completed, the narrative engagement questions were given in a printed form to the participants. Participants were also asked if they had any further comments or questions regarding the session or system.

6.3.2 Sessions 2 to 5

During the following sessions, participants were not guided through each task but rather observed and aided whenever it was required. The purpose for this change was to identify a learnability trend as well as the easiness in navigation and user control.

Every session followed the same protocol:

1. Measure glucose/blood pressure and register level
2. Allow participant to interact with Chreune
3. Request the fill out of narrative engagement forms
4. Invite participant to express any concerns regarding the session

6.3.3 Session 5

The last session was augmented by presenting the participants with forms containing questions from three of the research instruments: UEQ, TSRQ and NPS. To finalize the session, a semi-structured interview was conducted to capture thoughts regarding: the inclusion of Chreune in their routine, feelings that Chreune might have elicited, sharing the experience with acquaintances and further developments.

7. RESULTS

Different observations, experiences and thoughts were gathered throughout the trial period of Chreune. As expected, all information accrued required to be classified before a further analysis was performed. In this chapter, the information is presented according to their purpose and relevance. The chapter that follows, discusses the results and how they relate to the overall purpose of Cheune.

7.1 Noncommunicable disease and lifestyle

As mentioned in chapter 3, context awareness is imperative for the creation of a usable system. Comprehending the scenario in which Chreune was evaluated began with having participants explain the treatment they were following and how it had affected their lifestyle. More specifically, participants highlighted how three items in their routines had to be modified upon starting a treatment for their illness: changing diets, adhering to strict schedules and consuming diverse medication. Even though these activities are feasible, participants acknowledged how determent occurs easily when trying to accomplish them.

Participants described how dietary changes were difficult to achieve because of different factors. An overabundance of alimentary options, peer pressure and erratic schedules contributed to unsatisfactory attainment of a healthy diet. As participant 5 mentioned:

"*It's hard to resist cravings...I would also like to change my children's habits but sometimes they boycott me and get junk food, bring pizza, etc*."

Similarly, Participant 4 commented:

"My daughter tells me not to eat sweets, but them my husband would say 'Leave your mom alone and let her eat whatever she wants.""

Meanwhile, Participant 11 complained about the hardship of eating at specific time intervals throughout the day. In her context, workplace policies refrain from designating a specific lunch time yet coerce employees to work nonstop.

Timing appeared to play a bigger role; not only for dietary matters but also for consumption of medication and additional activities revolving their treatment (i.e. exercise sessions and doctor appointments). Regarding medication, participants with a high blood pressure condition indicated they ought to follow a rigorous regimen where various medicines (Figure 25) are ingested at predefined times. Alternatively, the diabetic participants in the study faced a different struggle since their main medication (i.e. insulin) needed to

be consumed prior to any meal. Being constantly aware of time and items becomes then an additional burden of stress in patients' lives.

Figure 25 Various medications from a participant suffering from high blood pressure.

Along with diet, schedules and medications; participants made remarks that uncovered the effect of stress either when discussing the cause of their illness or their current conditions. As an example, participant 4 narrated how stress might have been the trigger to discover her condition:

"I learned I was pre-diabetic because I had a car accident and I got very scared. I didn't get any injuries, but after that I started feeling more tired than usual and got some tests done; that's when the doctor told me about my condition."- P5

For participants 1, 4 and 8, stress came after knowing about their disease:

"(Doctor suggested to) Lower stress, no meats, no carbs, no salt, no milk (but cheese is ok). I've gotten used to it."-P1

"*Worrying about my health is time consuming and sometimes I need to rush to take my insulin and then get done with my other activities."*-P4

"Something that I would like to change are the high blood pressure peaks because they are a latent danger. I'm scared of the consequences…that something bad happens." -P8

Overall, remarks made by patients helped identify 4 main factors to be considered in systems design for NCDs: diet, schedules (timing), medications and stress management. Schedules and stress management were considered during inspiration and implementation stages of the design. For future designs, diet and medications must be included as guidelines to create a product that befits better the lifestyle of the user.

7.2 Biological measurements

As stated in Chapter 6, glucose or blood pressure measurements were performed at the beginning of each session of the trial period (see Appendix I). For the patients who suffered from high blood pressure, the maximum value registered for systolic blood pressure was 157 mmHg while the lowest was 107 mmHg. For the diastolic blood pressure, the highest value was 93 mmHg and the lowest was 65 mmHg. Blood pressure levels were mostly below the critical threshold [1] with an average of 124 mmHg for systolic and 78 mmHg for diastolic (Figure 26).

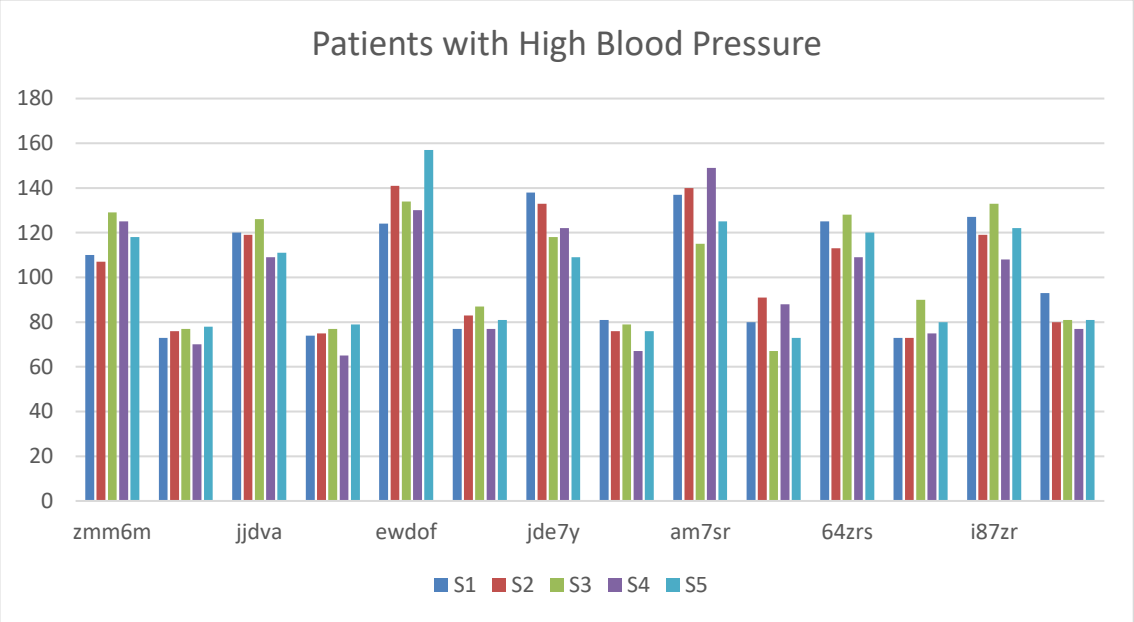


Figure 26 Patients diagnosed with high blood pressure

The participants with a diabetic condition presented glucose levels that ranged from 102 to 374 mg/dL (Figure 27). An average of 208.53 mg/dL was determined from the measurements performed on participants, positioning measurements above the 'normal' threshold [2]. The graph shows the measurements of 2 diabetic patients and one prediabetic

[1] Raised blood pressure is "defined as systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg" [46]
[2] The World Health Organization stipulates 126 mg/dl or more of plasma glucose concentration as an indicator of a rise in diabetic conditions. [46]

patient (i.e. yrs75). As expected, the participant with a pre-diabetic condition had lower measurements than the diabetic ones.

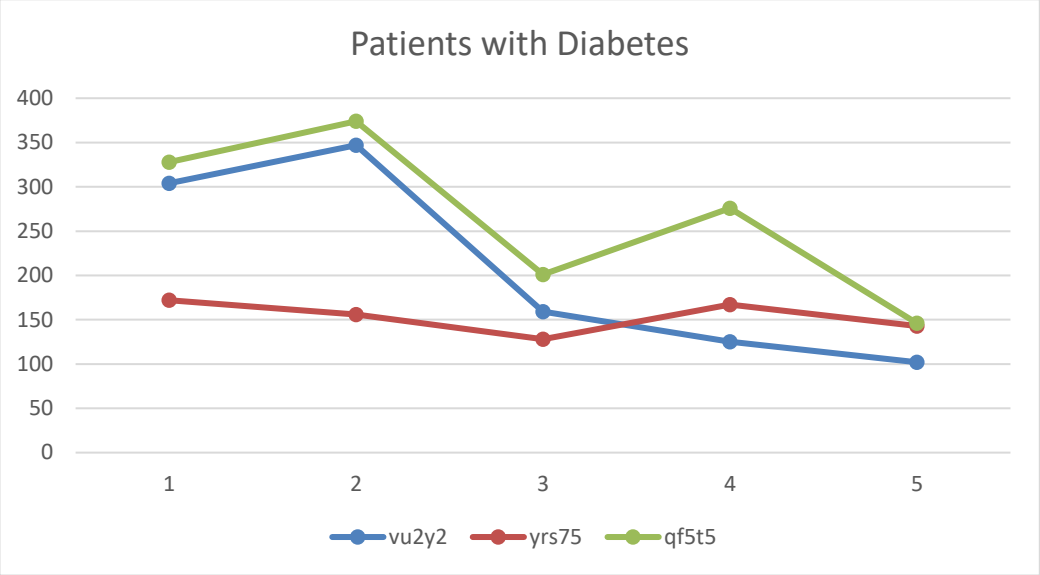


Figure 27 Participants diagnosed with diabetes or a pre-diabetic condition

Each measurement was disclosed to the participant from whom it was obtained, as the numerical value would be used afterwards when interacting with Chreune. It must be mentioned that, upon acknowledging the value, some participants proceeded to independently explain the cause of disparities when found. Although visual contact was minimized to avoid intimidating the participants, the possibility of eliciting explanations due to social pressure cannot be discarded in this situation. Nevertheless, participants used this moment to ponder on the cause of the results instead of only accepting the result. As an example, patient 4 and patient 5 recalled the food they had eaten previously during two of the sessions.

"*This can't be right! [Lists the food she had eaten previously that day] Oh, well… I had pastries…but I also had my insulin!"* -P4 (Session 2)

"I ate a piece of cake today and I wanna know what happens so that I can actually see the consequences" -P5 (Session 3)

Meanwhile, patients 6 and 7 mentioned that they had missed their blood pressure medicine that day:

"*I didn't take my medicine today*" -P6 (Session 2)

"*Oh! Today I didn't have my pills!"* -P7 (Session 5)

Overall, biological measurements were obtained typically at the same time every day of the trial period. However, due to the nature of the experimental conditions (i.e. obtaining measurements before or after work hours), measurements were not expected to be entirely consistent. Interestingly, the glucose levels for diabetic patients showed a decreasing trend.

7.3 Usability evaluation & User Experience Questionnaire

Once the biological measurements were obtained at the beginning of the session, the focus of the observations was placed on the interaction with Chreune. Throughout the follow-up of the interactions with the system, usability problems were identified to comply with a holistic evaluation of a prototype. Table 4(a) presents a categorization of the problems found as a result of the heuristic evaluation [194] performed during each session (see Section 6.3.1: Table 3). Table 4(b) summarizes the number of instances found per severity of issue [197]. For further details, please refer to Appendix J.

Table 4a Types of usability issues

Heuristic principle	**No. of instances**
Visibility of system status	4
Match between system and real world	1
User control and freedom	1
Error prevention	1
Help recognize errors	1
Help & documentation	2
Technical	1
Cosmetic	1

Table 4b Occurrences of usability issues

Severity of issue	No. of instances
Major	4
Minor	6
Cosmetic	1

For the most part, the user interface requires to be redesigned with a style that evokes direct manipulation and that considers slight problems with vision and usage of a mouse or pointer. This concern aligns with the knowledge of having a user group who rarely interacts with digital visual interfaces. As participant 5 pointed out:

"Newer generations use the phone all the time. We (the older ones) are used to little notebooks." -P5

Possible solutions to this could be the usage of physical buttons to navigate or creating a theme that could resemble a book where participants could turn the page to the next chapter. Incorporating pieces of hardware to accomplish this task may also prove increase perceivable feedback. Aiming towards the usage of a multimodal interface could also evolve in an increase of engagement. Capturing more of the users' attention would facilitate entering in a state of flow.

Along with observing interactions, times spent during each session were recorded for statistical purposes (Figure 28). In terms of time, participants interacted with the system an average of 7 minutes 55 seconds. This represents almost half the time allocated for each session to be performed (see Section 6.3)

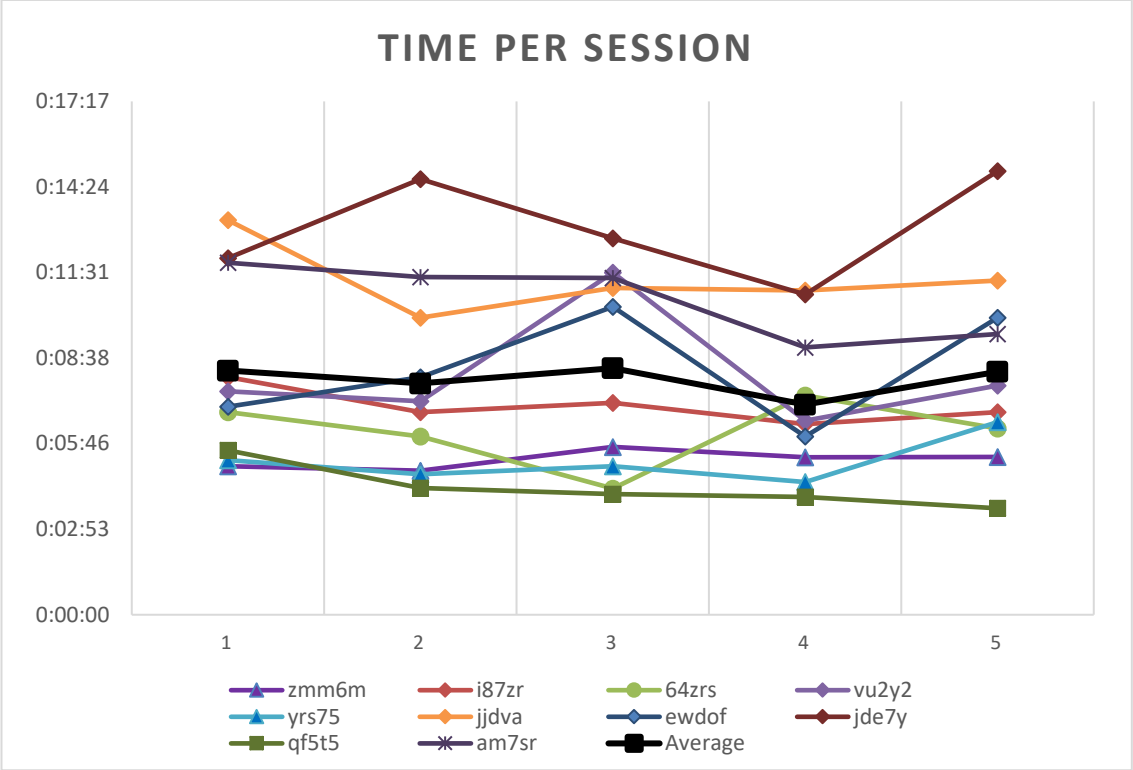


Figure 28 Time per session per participant

Furthermore, additional time was consumed primarily by either interruptions or the decisions made by participants when opting for a reviewal of the two endings. Even so, none of the participants spent more than 15 minutes interacting with Chreune. This may appear as a desirable scenario if Chreune were to be deployed in healthcare centers, since most medical appointments require patients to be present at least 15 minutes ahead of schedule. This 15-minute waiting time can be seized by patients to interact with Chreune. In due time, empowering patients while offering entertainment before an appointment could change the expectations when the former takes place. For instance, sad endings could elicit thoughts on how to improve their routines and participants may externalize these concerns during the meeting with their physician. Furthermore, instead of expecting their caregiver to deliver orders, participants may find themselves yearning to obtain additional information on their own. In any event, engaging the participant for a brief and effective time will depend on factors beyond the content and presentation.

As described in section 6.2.2, one of the instruments used in this evaluation was the User Experience Questionnaire (UEQ). The UEQ was implemented to determine how Chreune was perceived by the participants. Evaluating on a scale from -3 to +3, it can be observed in Table 5 that Chreune reached high scores in Attractiveness, Perspicuity (i.e. Transparency) and Novelty. Interestingly, the Efficiency dimension was not evaluated with the lowest score (as was expected due to possible technical difficulties). However, the Dependability dimension managed to get the lowest score due to difficulties in navigation.

Table 5 UEQ Scales and results for Chreune
(Arrow pointing up shows a positive tendency on the dimensions)

UEQ Scales	
Attractiveness	↑ 2.357
Perspicuity	↑ 2.179
Efficiency	↑ 1.821
Dependability	↑ 1.464
Stimulation	↑ 1.571
Novelty	↑ 1.893

Although Attractiveness and Perspicuity were the highest rated dimensions, participants articulated verbal remarks regarding the Novelty dimension. These remarks included: how they "hadn't interacted with something like this before" (P6), that they "hadn't seen something like this" (P7), that this was "an option to think in another way (about their health)" (P8) and how they "had never used a computer this much. It was a novelty (for them)" (P9). With these findings, it can be said that Chreune managed to capture attention and became attractive to an audience unfamiliar with interactive systems that involved a story controlled by their actions.

7.4 Decisions

As described in the design of Chreune (see Section 5.2.2), depending on which range was their blood pressure or glucose level measurement located, participants could unlock both endings: happy (characters thrive) and sad (characters face despair). If the number fell in the range of healthy measurements, the participant had the freedom to choose whether to see one or both endings in any order they desired. However, a measurement beyond the acceptable threshold left the participant with the only choice of a sad ending.

These decisions performed by each participant were recorded, and endings selected in each session are presented in Table 6.

Table 6 Decisions from participants throughout the trial period of Chreune

Participant	S1	S2	S3	S4	S5
zmm6m	H	S	H-S	S-H	H
i87zr	S-H	H	H	S	H
64zrs	H	H	S	S-H	H
vu2y2	S	S	S	S	S
yrs75	S	S	H*	S	S
Jjdva	H-S	S	H-S	H-S	H-S
Ewdof	H	S	S	S	S
jde7y	H-S	H-S	H	H-S	H-S
qf5t5	S	S	H*	H-S*	H
am7sr	S-H	S	S-H	S	H

H	Happy
S	Sad (Only option)
S	Sad
S-H	Sad, then Happy
H-S	Happy, then Sad
*	Happy (modified threshold)

Biological measurement thresholds were modified in Chreune's code for three sessions (see Table 6). More specifically, these changes were done for participants who were prone to obtain unsatisfactory numbers. The reason behind this decision was to examine the behavior of those participants when presented with the possibility of choice. It is important to note that this decision was made after observing that diabetic patients were more likely to have high glucose measurements during sessions. Timing for sessions becomes then a vital aspect to consider, since Chreune users could be denied choice if the routine is disrupted.

In term of percentages, figure 29 presents a summary of the amount and type of endings reviewed. As it can be observed, a 58% of the sessions included the revision of a happy ending and 28% of total sessions terminated with participants selecting only a happy ending. In contrast, 72% of the sessions included the reading of a sad ending either by choice or due to the rules of Chreune (42% were only given a sad ending as an option). Only 14% of sessions terminated in reading only the sad ending in spite of having the happy one as an option. Sessions where participants read both endings accounted for 30% of the total. When asked about their choices, some participants mentioned that their selection was based on their own mood or on what they thought was more likely to happen. Thus, even though they would be presented with a 'Happy' option, the storyline made more sense to have a 'Sad' ending and thus they would choose that one. Despite being a fictional story, participants expectations on the story gradually changed upon conceiving the ending as part of the narrative instead of an isolated event. This result matches the path of evolution in the Patient Health Engagement (PHE) model, where patients in the last phases know and understand the consequences of their actions. In this case, of the main character's actions.

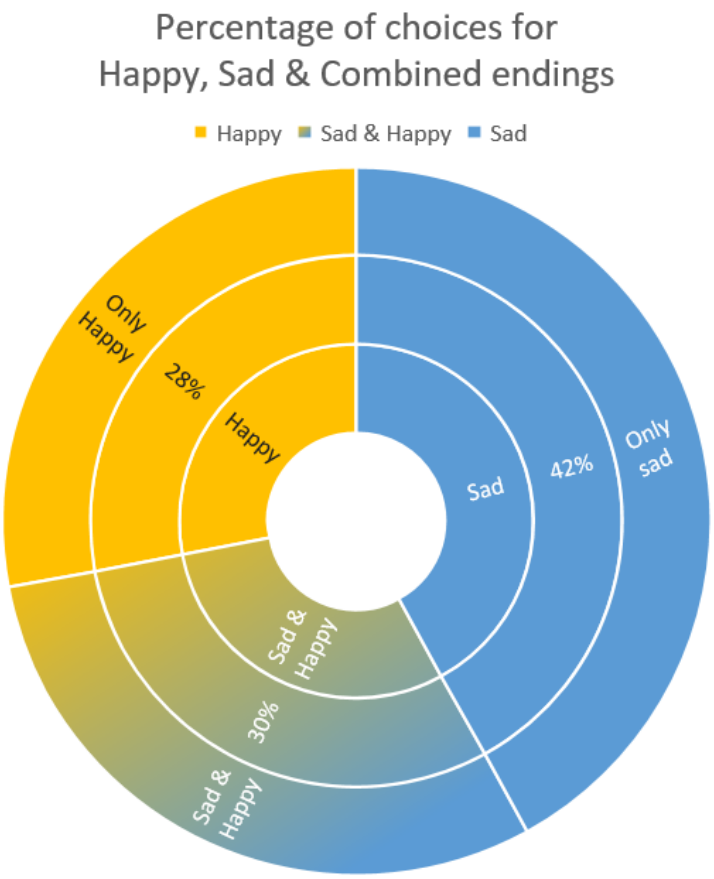


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Figure 29 Percentages of choices for Happy, Sad & Combined endings

7.5 Self-regulation (Involvement)

Part of this research examined the effects of using a persuasive interactive storytelling instrument on motivation and autonomy in participants, which was done evaluating the Treatment Self-Regulation Questionnaire (TSRQ) results obtained at the beginning and end of the study. As described in section 6.2.2, TSRQ intended to measure how likely were patients motivated to carry health-related behaviors by intrinsic rewards rather than extrinsic.

Average scores for autonomous and controlled regulation can be observed in Table 7 along with the relative autonomous index (RAI). Among participants, autonomous regulation indexes surpassed those of controlled regulation at both the beginning and the end of the study. In Table 8, the differences among results indicate an increase in autonomous regulation for 5 of the participants with an average of +0.658 points. A decrease in the same area happened for 4 of the participants with an average of 0.75 points. For one participant, autonomous regulation at the end of the study did not appear to differ from the evaluation conducted at the beginning of the process. Meanwhile, controlled regulation only increased for 4 participants with an average of +0.52 points. Opposingly, the

same number of participants saw a decrease of 0.59 points in the same dimension. Two participants did not report any modifications to their controlled regulation level. Finally, RAI showed an average increase of 0.654 points for 5 participants. Meanwhile, for the remaining 5, the RAI score decreased by 0.538 points.

Table 7 Comparison of Autonomous Regulation, Controlled Regulation and Relative Autonomous Index before and after the study

	Beginning			End		
Participant	Autonomous Regulation	Controlled Regulation	RAI	Autonomous Regulation	Controlled Regulation	RAI
zmm6m	4.57	3.36	1.21	5.57	3.00	2.57
i87zr	5.00	2.55	2.45	6.14	2.55	3.6
64zrs	3.71	3.55	0.17	3.86	3.82	0.04
vu2y2 (D)	5.29	3.55	1.74	4.43	3.18	1.25
yrs75 (PD)	4.43	2.45	1.97	4.00	1.91	2.09
jjdva	7.00	2.64	4.36	7.00	3.55	3.45
ewdof	4.57	3.00	1.57	3.43	1.91	1.52
jde7y	5.57	2.82	2.75	6.43	3.18	3.25
qf5t5	6.00	2.73	3.27	5.43	3.27	2.16
am7sr	6.86	5.91	0.95	7.00	5.91	1.09

Table 8 Comparison of Autonomous Regulation ($AReg_e$ - $AReg_b$), Controlled Regulation ($CReg_e$ - $CReg_b$) and Relative Autonomous Index (RAI_e - RAI_b)

Participant	Autonomous Regulation Change	Controlled Regulation Change	RAI Change
zmm6m	+1.00	-0.36	+1.36
i87zr	+1.14	0	+1.15
64zrs	+0.15	+0.27	-0.13
vu2y2 (D)	-0.86	-0.37	-0.49
yrs75 (PD)	-0.43	-0.54	+0.12
jjdva	0.00	+0.91	-0.91
ewdof	-1.14	-1.09	-0.05
jde7y	+0.86	+0.36	+0.5
qf5t5 (D)	-0.57	+0.54	-1.11
am7sr	+0.14	0	+0.14

Increased
Decreased
Same

With this data, results become debatable as to whether Chreune can help increase autonomous regulation. On one hand, the population for the study cannot be considered significant due its modest size. On the other hand, both autonomous and controlled regulation appear to have increased at the end of the study. Nevertheless, results do show a 27%

increase in autonomous (i.e. intrinsic) regulation versus controlled (i.e. external) regulation. Similarly, a 22% increase is observed for positive results in RAI versus the negative results. This scenario, although inconclusive, does expose a variation in participant's perceptions. Furthermore, the variations themselves open the possibility for Chreune to serve as a trigger in participant's introspections regarding their treatments. It is then when attention and content require a reviewal to provide a better ground for Chreune to succeed.

7.6 Interest

Participants were required to evaluate their perception regarding the narrative content they had been exposed to during the session (Figure 30). They were presented with a set of 6 questions, three regarding emotional engagement and three more attaining narrative understanding (see Appendix F).

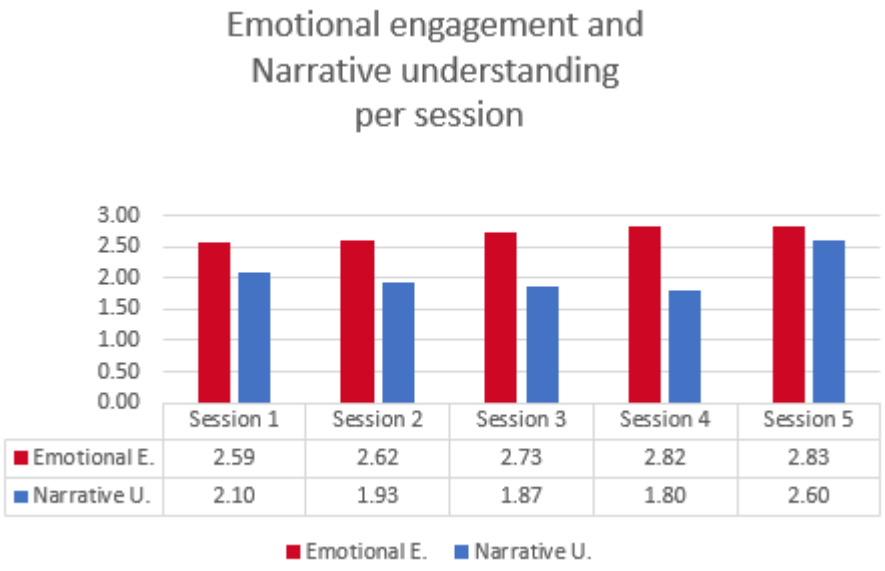

Figure 30 Emotional engagement and Narrative understanding per session

In average, emotional engagement obtained a score of 2.71 points, which sets it between the 'totally disagree' range (1-2 points) and the neutral range (3-5 points) on a 7-point Likert scale. As Table 9 shows, the statements related to identification with characters scored higher than the one related to the story. This may be in line with Keen's Narrative Empathy work (see section 1.1) and the ability of participants to embrace part of the characters' situation as their own. Having a character with the same condition as the participant makes it more likely to adopt their point of view as participants can see themselves (or part of them) reflected in the character. As an additional effect, two participants requested more information regarding the real series to continue with the story.

Meanwhile, for narrative understanding, the average score was set to 2.06 points. This score denotes a low level of difficulty following the story, as the questions for narrative understanding point to problematics. Participants seemed to barely face understanding issues according to results in Table 9. Despite having a low level of difficulty, an average surpassing 0.5 points can be interpreted as a sign for improvement in the construction of content.

Table 9 Emotional Engagement and Narrative Understanding questions and score

Emotional Engagement			**Narrative understanding**		
The story affected me emotionally	During the episode, when a main character succeeded, I felt happy, and when they suffered in some way, I felt sad.	I felt sorry for some of the characters in the story.	At points, I had a hard time making sense of what was going on with the story.	My understanding of the characters is unclear.	I had a hard time recognizing the thread of the story.
1.9	3.25	3.1	2.4	2.15	2.05

In written forms, participants were reluctant to the accept an emotional engagement with the story. Nonetheless, they did express concern about the characters and the story such as:

"*Parents find it hard to make children understand what is important to them...”* -P2 (referring to conflict between main character and his sons)

"I was interested in the characters." -P3

"I can identify with the character, because sometimes you don't realize that it's happening to you until you see it happening to someone else.” – P5

"I would like to see a stronger story, like my family's story. THAT was really shocking." -P9

Not surprisingly, participants alluded to their own stories throughout the sessions and compared them against the fictional one. As discussed previously in section 2.3.2, self-identification is one of the fundamental concepts of Narrative Engagement as it allows for introspection. Interestingly, this process matches the statement by Nunes et al [10] and explains how patients who reflected on their medical data were keener to conjecture on their behavior, state and further development.

As part of their daily ritual, Chreune was ranked as a ‘frequent’ tool to be used during the patients’ treatments. In this scope, various participants declared that they found useful the usage of Chreune to track their measurements. Some of the comments related to this were:

"*I think it's useful because I can see my treatment is working daily*." -P1

"*It made me realize I was fine most of the days."* -P3

"*I think it's good because it keeps you calm and in a fun way. It's good specially to foster a habit in people who don't have one*." -P6

"*I could not recommend this with a 10 because 5 sessions are not enough. Should be longer, 15 minutes at least not 3 or 4 to actually influence emotions."* -P7

"*I was able to get my pressure measured for a week so that was good*." -P9

In this same scope, it must be mentioned that Participant 1 showed up at the premises where the sessions took place even after the study had concluded. Her blood pressure was measured and, although there was no more content to provide to her, she stated:

"I'm just coming out of a habit now." -P1

The comments suggest that Chreune has the possibility to fit adequately in a patient's ritual without being a tedious tool. Correspondingly, a tool considered attractive as well as novel and befitting found its shareable evaluation to be high.

Based on a Net Promoter Score (NPR), Chreune obtained an average of 9 points on a scale of 1 to 10 (see appendix G). This translates to a high likelihood that users shared this system with people they know. Close relatives, friends and co-workers were mentioned as people with whom participants had discussed their trial with Chreune. This presents a promising future for Chreune, as involving close acquaintances can also reinforce the support systems that noncommunicable disease patients have.

To summarize, the insights expose the importance of context (e.g. diet, times, medication, stress levels, participants' stories, etc.) in the success of a system attempting to appeal to older noncommunicable disease patients. Conspicuously, the content presented (i.e. story and multimedia elements) plays a major role in fostering an engaging link between Chreune and the user. Even though an absolute increase in autonomy could not be verified as an outcome of usage, Chreune did manage to position itself as an appealing tool that could foster an amusing habit.

8. DISCUSSION & CONCLUSIONS

Habitual behavior changes are required for NCD (current and preemptive) treatments to succeed. For this to happen, efforts should not reside only in healthcare organizations, as it has been described that some objectives and philosophies are shared with the entertainment industry. For this reason, involving the latter in monotonous tasks may help increase the effectiveness of the message that the healthcare system attempts to deliver. This work intended to explore different dimensions of human development merging towards one goal: to study the effects of controlled interactive telenovelas as tools to increase engagement in treatments for NCD patients.

The combination of soap operas & interactive storytelling intended to deliver a tool whose purpose was to support a patient's eudaimonic well-being. As stated in Chapter 1, the first inquiry to address for this research meant to explore the way smart storytelling was experienced by NCD patients. From the analysis presented in Chapter 7, daily monitoring in conjunction with a captivating interactive drama was perceived as enjoyable and did elicit introspection. Compulsory interactions and immediately available feedback served as incentives for participants to ask questions regarding their previous decisions and created narrative expectations for further sessions. However, evaluations in other areas uncovered issues that were not considered during the design phase.

Most of the usability issues, for starters, found their root cause in a narrow conception of the users and their physical needs (e.g. blurry vision due to high glucose, unfamiliarity with a laptop mousepad, etc.). Meanwhile, a small population delivered inconclusive self-regulation scores which could -in the future- help validate whether Chreune can be a tool that truly helps patients become more autonomous. Additionally, the presence of a moderator may have been perceived as a type of social pressure that triggered the questioning of measurements as opposed to intrinsic motivation in participants. Finally, the short-term study can only be considered a window that helped unveil the easiness of adoption on a tool designed for long-term engagement efforts.

The storytelling and interactive components made Chreune a candidate to study the dynamics of engagement. In the second inquiry of this work, Chreune was used to evaluate which dimensions of engagement were stimulated and how. In the 'Interest' dimension, Chreune appeared to be attractive to the demographic selected - as a tool - but demonstrated room for improvement in the narrative engagement - as a story - area. In the 'Involvement' dimension, the insights for Chreune did fluctuate in self-regulation levels (i.e. autonomous and controlled) yet the changes cannot be considered significant. This situation makes it prone for additional evaluations to obtain a more compelling panorama.

Overall, Chreune uncovered the possibility for a niche that has yet to be exploited: interactive storytelling in healthcare for adults.

Throughout the process of answering the 2 mains questions in this work, the design and development of Chreune uncovered multiple lessons in distinct paths.

The first lesson is the importance of systems thinking when designing a product. A holistic view of the problem can facilitate the creation of a successful solution. In this case, the ideation phase made use of several topics that ranged from psychological and philosophical to social and technological. The second one is the extraordinary opportunity that pervasive computing has created in terms of market penetration. Populations who had not been exposed to digital systems in the past can now approach them effortlessly. Interfaces that emulate real world interactions are becoming more prevalent and allowing more people to make use of electronic tools. The massive approach comes with a bigger responsibility for user experience designers, which is the third lesson learned from this work. User experience designers are not only responsible for the interactions between user and machine but also for the expectations and the aftereffects. In Chreune's development, this was unveiled when participants disclosed other unrecognized problems related to their condition (e.g. blurred vision when not in a healthy state, lack of support or reassurance to maintain healthy habits, minimal interactions with visual user interfaces in the past, etc.). Correspondingly, the unforeseen actions after the trial period (e.g. returning to venue to get their measurements, asking for more episodes, etc.) reinforced the significance of testing a prototype before deploying a product. Finally, the last lesson in this project is that tedious tasks can indeed benefit from the implementation of gamification principles to allure users while dealing with real life problems. In this context, the evaluation phase revealed that more realistic dilemmas are -sometimes- more enticing than fictional ones.

Chreune's efforts to bring real life to matter (i.e. using a soap opera with moving images of real people) made it possible for spectators to identify themselves with the narrative. This feature is crucial for a tool that attempts to develop a bond with the user. Future development of a tool like Chreune could include stories portrayed by people who are either part of or located in the same community as the patients using the system. This could help establish a more empathic bond with the story and characters as well as more willingness to make them thrive. Interactions involving an approachable community have the opportunity of battling possible thoughts of loneliness when dealing with their disease. Additionally, endings could be categorized differently. For instance, some participants preferred the plausible ending regardless of whether it was a 'happy' or a 'sad' one. Using 'optimistic' or 'pessimistic' and even adding a third option (i.e. predictable) may uncover other reactions not contemplated during Chreune's evaluation. Following this line, further research of Chreune should contemplate patients with depression or suicidal

thoughts as custom interactive telenovelas may nurture hope or remind patients that there is always a better scenario available to them.

Being in touch with reality is essential for a product that intends to help in healthcare, yet it must be said that realities are perceived different among patients. In this study, most of the participants were positioned in later stages of PHE and were already familiar with their actions and their consequences. However, exposing Chreune to patients in earlier stages of PHE (i.e. blackout or arousal) might uncover more benefits of the system such as assimilating knowledge faster or becoming aware of situations inconceivable to them. Furthermore, the stories may resonate more if combined with characters they can self-identify. In this scenario, doctors could work along with Chreune's development team to customize a patients' path and highlight issues they might consider important for the user.

The ability to personalize products and services is a trend that Chreune should be keen to adopt in the future. By incorporating more game elements, such as a status and achievements, users can track their progress and become more knowledgeable of their own development. However, these additions should be planned carefully to avoid creating a fixation or misusage of Chreune. One possible risk is that patients might focus on the 'medals' won rather than why they are earning them. This situation would defeat the purpose of nurturing eudaimonic well-being and might not enable patients to truly have control over their disease. As is, with a minimal ludic tone, Chreune already showed it can trigger introspection but can be improved to fortify a long-term relationship with the user.

Last, but not least, it is worth mentioning that efforts are being carried by world renowned companies to incorporate interactive storytelling in popular services. Examples of this are that of Netflix adding interactive stories to their platform [195] and Amazon's Alexa Skills [196] that let you create and navigate through stories. Although purely entertaining, these companies have acknowledged the value of adding a type of interaction where the user can be conferred more control.

To conclude, eclectic solutions can now -more than ever- find the right audience to enrich ignored aspects that do make a difference in someone's life. Ultimately, the goal is to find how technology can set new opportunities to address problems without fear and uncertainty but with excitement and hope.

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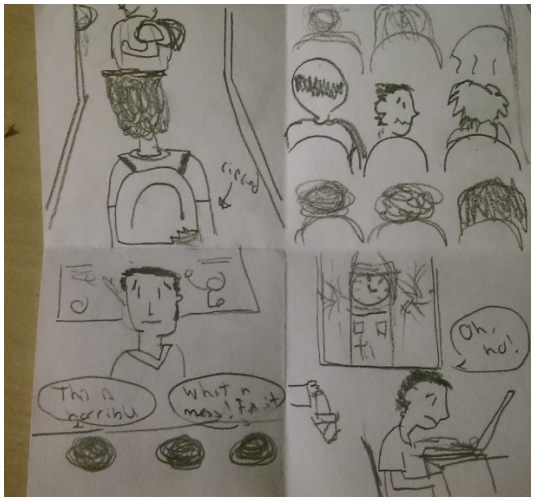
APPENDIX A: SWEET SERENDIPITY STORYBOARD

Scene	Description
	Raphael is a software architect. He's not always on time. He eats oatmeal for breakfast and listens to 80's songs in the morning (like "Eye of the Tiger" or "Final countdown"). He drives a convertible, he's first car and the one he had always dreamed about. He lives in Sydney and likes going to the beach everyday...he actually lives next to it. He's cheerful and likes coding with his friends at work. He's a hard worker and normally stays inside his office, but today, an extended lunch break will turn into an unexpected surprise.
	Raphael meets Sophia, who's a new hiree and got lost trying to find her office in the huge maze that the building is. Raphael happily volunteered to help her, as she seemed pretty lost in the hallway. He takes her to his office, where his laptop is, and looks for the map to show Sophia. They chat happily, she tells her she just arrived in town and doesn't know any places at all. Raphael offers to walk her to her office and, in the end, he asks her if she wants to grab lunch and she accepts.

	Raphael meets Sophia, who's a new hiree and got lost trying to find her office in the huge maze that the building is. Raphael happily volunteered to help her, as she seemed pretty lost in the hallway. Suddenly, Victor -Raphael's office neighbor- hears chitchat and enters Raphael's office. He introduces himself and starts talking about how rebellious Raphael is sometimes and all the silly things he does. "He's like the child of this floor". These comments are not making Raphael look so good. Victor and Raphael take Sophia to her office and, while Raphael answers a call from his boss, Victor manages to ask Sophia out for lunch and she agrees.
	Raphael's Boss has great news for him. Clients want to see the progress of the project and have requested that Raphael goes to London to present them the results. To celebrate this, Raphael manages to find Sophia, ask her how she's been doing and if she would like to go on a date. Sophia happily accepts, and Raphael picks her up in the evening. Although, because it was an impromptu date, he didn't have a nice plan but to order pizza and watch Youtube videos. However, Sophia loved the idea and they both play each other weird and funny videos that show bits and pieces of who they are. From comedians to classical music to weird dancing steps, they finish a wonderful evening and Raphael takes Sophia home.

	Raphael's Boss has news for him. Clients want to see the progress of the project and have requested that Raphael goes to London to present them the results. This doesn't look good, as the tone of that call meant that they were furious. A worried Raphael bumps into Sophia, makes small talk and asks her if she's like to go get dinner later on but she tells him that she already has dinner plans with Victor, his coworker. A discouraged Raphael goes home after a long day of work and finds out that distractions has taken a toll on him. Bills have piled up and his rent will soon increase, which means that he'll have to pay more or get evicted. The day ends with a sad Raphael, in the shadows, just wondering how he'll get through all of this.
	Raphael packs and goes on his journey to UK. Luckily, he gets seated next to a very kind old woman with whom he chats and gets recommendations on what to do while in London. It turns out, that this woman is part of a historical preservation society and invites Raphael to give her a call later and join a unique afternoon tea at a Victorian garden. Meanwhile, Raphael nervously presents his project and results and clients congratulate him on the efforts and praise all the hard work he's done. Later on, he goes for the afternoon tea and, a day later, goes back home.

	Raphael packs and goes on his journey to UK. The trip could not be worse. He gets a seat squished between a very corpulent guy and a hippie who supports water preservation and hasn't take a shower in 6 months. A long flight becomes unbearable and, as he arrives in London, he prepares for his presentation the next day. In the morning, he shows the clients all the progress of the project but they consider it as a lousy attempt and demand that he fixed a couple of things as soon as possible. The release of the final product depends on him and they are already 2 days late so he can't waste any time. For the next 2 days of his visit, Raphael spends pretty much all day coding and debugging...while looking through the window a lively metropolis that he might have a chance to discover next time.
	Raphael gets back to Sydney and gets an interesting thing on his mail. A VIP pass for the Marathon he had registered previously. He's quite excited because this is the first time he'll run a marathon and decides to seize the opportunity and ask Sophia if she'd like to help him train. She happily agrees and they both start meeting each weekend to jog next to the beach, sometimes they go hiking and all these encounters become small dates. After a month a half of preparation, Raphael finally gets his chance at the marathon and, even though he doesn't win 1st place, he does finish in the mid group while Sophia cheers for her him at the finish line.

	Raphael gets back to Sydney and gets an interesting thing on his mail. A VIP pass for the Marathon he had registered previously. He's quite excited because this is the first time he'll run a marathon...however, that evening he starts to feel ill. As the night goes by, Raphael's health worsens and calls one of his friends to take him to the hospital. Once there, the doctor tells Raphael that he has caught a virus while being on this trip and that he won't be able to leave his bed in at least 2 weeks. He's quite sad because this implies he won't be able to attend the marathon. A week goes by and Sophia pays him a visit. They talk about how he must've gotten the virus and how things have been at work, that new movie that got released and how there was a small party at work while Raphael was away. At the end of the visit, Sophia tells him she has news for him...that she got a better job offer in Hong Kong so she'll be moving away next week. As she wishes Raphael to get better and leaves, a very sad Raphael gets a call from his boss saying that they need him to get better soon because more work is coming his way...so there won't be a lot of time to rest.

Research plan

	Phase 1: Instrument creation & Verification	Phase 2: Evaluation session arrangements	Phase 3: Evaluation of Chreune	Phase 4: Analysis of results
Description	Review artifacts to be used during the research with supervisors	Set appointments at medical facilities	Conduct evaluation sessions of Chreune	Consolidate observations and responses from interactions with Chreune
Artifacts	• Consent forms • Semi-structured interviews (prior/after) • Chreune (story in Twine) • Narrative engagement evaluation	• Brief document explaining the purpose and structure of the study + translation • Chreune (story in Twine)	• Consent forms • Semi-structured interviews (prior/after) • Chreune (story in Twine) • Narrative engagement evaluation • PHE ✓ Tablet with internet access ✓ A/V recording device	• Responses from interviews • Data from evaluations
Actions	1. Review artifacts with supervisors 2. Iterate on revisions 3. Translate corrected versions 4. Review out of evaluation process	1. Schedule trip to Mexico 2. Determine suitable times and arrange dates with doctors (1st: Dr. Alan Gabriel Nophal Cruz, 2nd: Fundación Vive Tu Diabetes A.C, 3rd) 3. Scout & select patients	1. Prepare equipment for evaluation 2. Meet patients at predefined location 3. Conduct initial evaluation (Explanation, Consent forms, Semi-structured interview-p, PHE, interactive session) 4. Conduct 4 more interactive sessions 5. Conduct Semi-structured interview-a, PHE and Narrative engagement evaluation	1. Obtain statistics from narrative engagement evaluation, PHE and demographics 2. Create affinity diagram with responses from interview 3. Extract conclusions 4. Present and discuss results with supervisor
Dates	Weeks 14-15	Weeks 16-18	June	Late summer
Risk management (Probability /Severity)	P: Unavailability of supervisors to conduct revisions (H/5) S: Schedule shorter revision either virtual	P: Unable to travel to Mexico (M/5) S: Coordinate remote testing viable	P: Patients dropping out of the study (H/5) S: Recruit more patients at the beginning to prevent lack of data(+10)	P: Losing data (L/5) S: Create backups of data to prevent
	P: Unable to deliver instruments for revision (M/5) S: Reschedule deadline and act as soon as possible	P: Unable to schedule enough time to conduct 5 interactive sessions (M/5) S: Review plan with supervisors	P: Technical difficulties (S/5) S: Carry smartphone with data and save Chreune locally as an alternate plan	P: Statistical errors (M/5) S: Review procedures with supervisor

APPENDIX C: PARTICIPANT PROFILES

Participant	Codes	Age	Gender	Condition	Occupation	Education	Marital Status	No. of children
1	zmm6m	55	Female	High Blood Pressure	Teacher	High School	Divorced	2
2	i87zr	63	Female	High Blood Pressure	Teacher	College	Widow	2
3	64zrs	25	Female	High Blood Pressure	Teacher	College	Single	0
4	vu2y2	61	Female	Diabetes	Teacher	High School	Married	3
5	yrs75	50	Female	Pre-Diabetes	Teacher	College	Married	2
6	jjdva	64	Female	High Blood Pressure	Teacher	College	Married	3
7	ewdof	61	Female	High Blood Pressure	Retired	High School	Married	2
8	jde7y	66	Female	High Blood Pressure	Teacher	Junior High	Divorced	3
9	qf5t5	57	Female	Diabetes	Teacher	College	Married	2
10	am7sr	73	Female	High Blood Pressure	Retired	High School	Married	2
11	qf5t5	41	Female	Diabetes	Pharmacist	High School	Domestic partnership	2

APPENDIX D: CHREUNE CONSENT FORMS (IN SPANISH)

Chreune

Formulario de consentimiento

Por medio de la presente se le invita a participar en la evaluación de un sistema (Chreune) para apoyar a pacientes con enfermedades crónicas. El objetivo es recabar información sobre la percepción y posicionamiento del sistema en tratamientos a largo plazo. El sistema presenta historias interactivas que responden a valores de indicadores fisiológicos.

La evaluación consiste en un periodo de pruebas de 5 sesiones, cada una realizada en un día diferente. En cada sesión, se le medirá el indicador fisiológico acorde a la enfermedad que presenta. Este valor será utilizado para proceder con la historia interactiva. Posteriormente, usted podrá interactuar con el sistema siguiendo una serie de tareas que le serán entregadas y que le servirán de guía para navegar en la historia. Sin embargo, el sistema no le dará ningún tipo de indicación médica.

Al finalizar cada sesión, se le entregará un pequeño cuestionario para evaluar el impacto del capítulo presentado. En la última sesión, se le pedirá su opinión acerca de la experiencia en general.

Cada sesión durará alrededor de X minutos, por lo que le agradecemos de antemano su tiempo y contribución en este estudio.

La información que se reúna a través de los diferentes medios (cuestionarios y entrevistas) será totalmente confidencial y anónima. La información no será ligada con su identidad y sólo será manejada por la persona que modere las sesiones de evaluación. Los datos serán utilizados como parte de un trabajo de investigación del Departamento de Interacción Human-Tecnología de la Universidad Tecnológica de Tampere. La participación es este estudio es voluntaria y usted tiene el derecho de cancelar su participación en cualquier momento sin ningún tipo de explicación o repercusión.

Al firmar esta forma, acepto los términos que se me han descrito previamente.

Lugar y fecha: _____ Firma: _____

Nombre con letras de molde:_____

NO LLENAR

*No. De participante:*_____

Chreune

Formulario de consentimiento para uso de fotografías

Por medio de la presente se le invita a participar en la evaluación de un sistema (Chreune) para apoyar a pacientes con enfermedades crónicas. El objetivo es recabar información sobre la percepción y posicionamiento del sistema en tratamientos a largo plazo. El sistema presenta historias interactivas que responden a valores de indicadores fisiológicos.

La evaluación consiste en un periodo de pruebas de 5 sesiones, cada una realizada en un día diferente. Durante las sesiones, se grabará el audio para corroborar información que se obtenga por lo que se le sugiere hacer comentarios en voz alta. Así mismo, se tomarán fotografías que permitirán ilustrar el contexto y desenvolvimiento de la evaluación. El material fotográfico puede formar parte del trabajo publicado, no obstante, su identidad será protegida en todo momento.

Una vez que el trabajo de investigación haya finalizado, aquel material que no haya sido utilizado en la publicación será destruido.

La participación es este estudio es voluntaria y usted tiene el derecho de cancelar su participación en cualquier momento sin ningún tipo de explicación o repercusión.

Al firmar esta forma, acepto los términos que se me han descrito previamente.

Lugar y fecha: _____ Firma: _____

Nombre con letras de molde:_____

NO LLENAR

No. De participante:_____

APPENDIX E: MEDICAL HISTORY, PATIENT HEALTH ENGAGEMENT (PHE) QUESTIONNAIRE, TREATMENT SELF-REGULATION QUESTIONNAIRE (TSRQ) AND SEMI STRUCTURED INTERVIEW QUESTIONS (IN SPANISH)

Chreune

Historial

Esta forma tiene como intención recolectar información sobre las características de los participantes en este estudio. La información que se obtenga permanecerá anónima y no será distribuida sin el consentimiento previo del participante.

Datos generales

1. **Edad:** _____
2. **Género:** *Femenino* *Masculino* *Prefiero no contestar*
3. **Ocupación:**_____
4. **Estado civil:**

   a) *Soltera/o*
   b) *Casada/o*
   c) *Viuda/o*
   d) *Comprometida/o*
   e) *Divorciada/o*
   f) *En Unión libre*

5. **No. De hijos:** _____
6. **Nivel máximo de estudios completados:**

   a) Sin estudios
   b) Primaria (1 a 6 años)
   c) Secundaria (7 a 9 años)
   d) Preparatoria / Estudios técnicos o comerciales con primaria terminada y secundaria (10 a 13 años)
   e) Universidad / Licenciatura
   f) Maestría / Doctorado / Postdoctorado

7. **Área residencial donde habita:** Urbana Rural

NO LLENAR

*No. De participante:*_____

Relación Paciente-Tratamiento

8. **Enfermedad crónica:** Hipertensión Diabetes Otra:_____

9. **Parámetro medido:** Presión arterial Glucosa Otro: _____

10. **Año de diagnóstico:** _____

Con respecto a su enfermedad, elija la opción que mejor describa su estado. Puede escoger una opción intermedia cuando sienta que está entre dos estados.

A. Con respecto a mi enfermedad yo...

1	2	3	4	5	6	7
Siento que no sé nada		Esto en alerta		Estoy consciente		Me siento positiva/o

B. Con mi condición yo...

1	2	3	4	5	6	7
Me siento confundida/o		Estoy en problemas		Estoy consciente		Me siento en serenidad

C. Cuando pienso en mi enfermedad yo…

1	2	3	4	5	6	7
Cuando pienso en mi enfermedad, me siento abrumada/o con emociones		Me siento ansiosa/o cada vez que surge un nuevo síntoma		Me acostumbré a mi enfermedad		A pesar de mi enfermedad, veo coherencia y continuidad en mi vida

D. Con respecto a mi enfermedad yo...

1	2	3	4	5	6	7
Me siento muy desanimada/o debido a mi enfermedad		Me siento ansiosa/o cuando trato de manejar mi enfermedad		Siento que me he adaptado a mi enfermedad		Generalmente, soy optimista acera de mi futuro y mi condición médica

NO LLENAR

No. De participante:_____

E. En este momento yo…

1	2	3	4	5	6	7
Me siento totalmente oprimido por mi enfermedad		Me siento triste cuando surge un nuevo síntoma		Siento que ya he aceptado mi enfermedad		Puedo verle sentido a mi vida a pesar de mi enfermedad

F. ¿Usted olvida tomas sus medicamentos en algún momento? Sí No

G. ¿A veces es descuidada/o con respecto a sus medicinas? Sí No

H. Cuando se siente mejor, ¿usted a veces deja de tomar sus medicinas? Sí No

I. A veces, si se siente peor cuando toma sus medicinas, ¿usted deja de tomarlas? Sí No

Tratamiento

Elija la opción que determina qué tan cierta es la frase en su caso.

Yo tomo mis medicinas y/o me checo porque…

	Totalmente falso		**Tiene algo de cierto**			**Totalmente cierto**	
	1	**2**	**3**	**4**	**5**	**6**	**7**
Otras personas se enojarían conmigo si no lo hiciera.							
Me parece un desafío personal hacerlo.							
Creo personalmente que controlar mi diabetes mejorará mi salud.							
Me sentiría culpable si no hiciera lo que mi doctor me dice.							
Quiero que mi doctor piense que soy un buen paciente.							
Me sentiría mal conmigo mismo/a si no lo hiciera.							
Es emocionante tratar de mantener mis niveles en un rango saludable.							

NO LLENAR

No. De participante:_____

No quiero que otras personas se sientan decepcionadas de mí.							

La razón por la cual sigo mi dieta y hago ejercicio regularmente es porque…

	Totalmente falso		Tiene algo de cierto			Totalmente cierto	
	1	2	3	4	5	6	7
Otras personas se disgustarían conmigo si no lo hiciera.							
Creo personalmente que estas cosas son importantes para mantenerse saludable							
Sentiría vergüenza de mí mismo/a si no lo hiciera.							
Es más fácil hacer lo que me dicen que pensar en ello.							
He pensado cuidadosamente sobre mi dieta y ejercicio y creo que es lo mejor.							
Quiero que otros vean que puedo seguir la dieta y mantenerme en forma.							
Sólo lo hago porque mi doctor me lo ordena.							
Personalmente, siento que cuidar mi dieta y ejercicio son lo mejor para mí.							
Me sentiría culpable si no cuidara mi dieta y ejercicio.							
Ejercitarse regularmente and seguir mi dieta son elecciones que realmente quiero hacer.							
Es un reto aprender a vivir con mi enfermedad.							

NO LLENAR

No. De participante:_____

Entretenimiento

1. ¿Usted sigue alguna telenovela o serie de televisión? Sí No ¿Cuál(es)? _____
2. ¿Con qué frecuencia ve este programa?
    a) Todos los días
    b) Un par de veces a la semana
    c) Cada semana
    d) Cada quincena

¿Qué tan importante es para usted darle seguimiento a esta telenovela/serie?

a) Muy importante b) Moderadamente importante c) No es importante

---

Para ser llenadas por la/el moderador

¿Qué tratamiento se le ha prescrito? (Medicamentos, frecuencia de mediciones u otras actividades indicadas por el médico.

¿Qué cambios en su vida cotidiana ha tenido que llevar a cabo?

¿Qué tipo de dificultades se le han presentado desde que sigue su tratamiento?

¿Qué tipo de satisfacciones se le han presentado desde que sigue su tratamiento?

¿Qué le gustaría cambiar con respecto a su condición? Emocionalmente, físicamente, socialmente, etc.

¿Hay personas que le ayudan de alguna forma a lidiar con su enfermedad?

--Entretenimiento---

¿Por qué ve programas/telenovelas? ¿Cuándo?

¿Qué es lo que le llama la atención/motiva a verlos?

¿Usted comparte su experiencia de entretenimiento con más personas? ¿Quiénes? ¿Qué es lo que le lleva a compartir esta experiencia con ellos?

NO LLENAR

No. De participante:_____

APPENDIX F: EMOTIONAL ENGAGEMENT & NARRATIVE UNDERSTANDING FORMS FOR SESSIONS 1 – 4 (IN SPANISH)

Chreune

Sesión 1

	Totalmente en desacuerdo		No de acuerdo ni en desacuerdo			Totalmente de acuerdo	
	1	2	3	4	5	6	7
L a historia me afectó emocionalmente.							
Durante el episodio, cuando el personaje principal triunfaba, me sentí feliz y cuando sufría de cierta forma, me sentí triste.							
Sentí lástima por algunos de los personajes de la historia.							
En ocasiones, me costó trabajo entender qué estaba pasando con la historia.							
No entiendo claramente a los personajes.							
Me costó trabajo reconocer la trama de la historia.							

Sesión 2

	Totalmente en desacuerdo		No de acuerdo ni en desacuerdo			Totalmente de acuerdo	
	1	2	3	4	5	6	7
L a historia me afectó emocionalmente.							
Durante el episodio, cuando el personaje principal triunfaba, me sentí feliz y cuando sufría de cierta forma, me sentí triste.							
Sentí lástima por algunos de los personajes de la historia.							
En ocasiones, me costó trabajo entender qué estaba pasando con la historia.							
No entiendo claramente a los personajes.							
Me costó trabajo reconocer la trama de la historia.							

NO LLENAR
No de Participante:_____

Sesión 3

	Totalmente en desacuerdo		No de acuerdo ni en desacuerdo			Totalmente de acuerdo	
	1	2	3	4	5	6	7
L a historia me afectó emocionalmente.							
Durante el episodio, cuando el personaje principal triunfaba, me sentí feliz y cuando sufría de cierta forma, me sentí triste.							
Sentí lástima por algunos de los personajes de la historia.							
En ocasiones, me costó trabajo entender qué estaba pasando con la historia.							
No entiendo claramente a los personajes.							
Me costó trabajo reconocer la trama de la historia.							

Sesión 4

	Totalmente en desacuerdo		No de acuerdo ni en desacuerdo			Totalmente de acuerdo	
	1	2	3	4	5	6	7
L a historia me afectó emocionalmente.							
Durante el episodio, cuando el personaje principal triunfaba, me sentí feliz y cuando sufría de cierta forma, me sentí triste.							
Sentí lástima por algunos de los personajes de la historia.							
En ocasiones, me costó trabajo entender qué estaba pasando con la historia.							
No entiendo claramente a los personajes.							
Me costó trabajo reconocer la trama de la historia.							

NO LLENAR
No de Participante:_____

APPENDIX G: EMOTIONAL ENGAGEMENT & NARRATIVE UNDERSTANDING FORMS FOR SESSION 5, USER EXPERIENCE QUESTIONNAIRE (UEQ), TREATMENT SELF-REGULATION QUESTIONNAIRE (TSRQ) AND NET PROMOTER SCORE (NPS) FORM (IN SPANISH)

Chreune

Sesión 5

	Totalmente En desacuerdo		Ni de acuerdo ni en descuerdo			Completamente de acuerdo	
	1	2	3	4	5	6	7
La historia me afectó emocionalmente.							
Durante el episodio, cuando el personaje principal triunfaba, me sentí feliz y cuando sufría de cierta forma, me sentía triste.							
Sentí lástima por algunos de los personajes de la historia.							
En ocasiones, me costó trabajo entender qué estaba pasando con la historia.							
No entiendo claramente a los personajes.							
Me costó trabajo reconocer la trama de la historia.							

Cuestionario de Experiencia del Usuario

1. *Por favor seleccione la opción que mejor describa el sistema que ha utilizado durante el periodo de pruebas. Elija el nivel que mejor crea entre cada par de características listadas.*

A usted, el sistema le pareció…

	1	2	3	4	5	6	7		
desagradable								agradable	1
no entendible								entendible	2
creativo								sin imaginación	3
fácil de aprender								difícil de aprender	4
valioso								de poco valor	5
aburrido								emocionante	6
no interesante								interesante	7

No. de participante: _____

impredecible								predecible	8
rápido								lento	9
original								convencional	10
obstructivo								impulsor de apoyo	11
bueno								malo	12
complicado								fácil	13
repeler								atraer	14
convencional								novedoso	15
incómodo								cómodo	16
seguro								inseguro	17
activante								adormecedor	18
cubre expectativas								no cubre expectativas	19
ineficiente								eficiente	20
Claro								confuso	21
no pragmático								pragmático	22
ordenado								sobrecargado	23
atractivo								feo	24
simpático								antipático	25
conservador								innovador	26

Tratamiento

2.-Elija la opción que determina qué tan cierta es la frase en su caso.

Yo tomo mis medicinas y/o me checo porque…

	Totalmente Falso		Tiene algo de cierto			Totalmente cierto	
	1	2	3	4	5	6	7
Otras personas se enojarían conmigo si no lo hiciera.							
Me parece un desafío personal hacerlo.							
Creo personalmente que controlar mi enfermedad mejorará mi salud.							
Me sentiría culpable si no hiciera lo que mi doctor me dice.							
Quiero que mi doctor piense que soy un buen paciente.							
Me sentiría mal conmigo mismo/a si no lo hiciera.							
Es emocionante tratar de mantener mis niveles en un rango saludable.							
No quiero que otras personas se sientan decepcionadas de mí.							

La razón por la cual sigo mi dieta y hago ejercicio regularmente es porque…

	Totalmente falso		Tiene algo de cierto			Totalmente cierto	
	1	2	3	4	5	6	7
Otras personas se disgustarían conmigo si no lo hiciera.							
Creo personalmente que estas cosas son importantes para mantenerse saludable							
Sentiría vergüenza de mí mismo/a si no lo hiciera.							
Es más fácil hacer lo que me dicen que pensar en ello.							

No. de participante: _____

	Totalmente falso		Tiene algo de cierto			Totalmente cierto	
	1	2	3	4	5	6	7
He pensado cuidadosamente sobre mi dieta y ejercicio y creo que es lo mejor.							
Quiero que otros vean que puedo seguir la dieta y mantenerme en forma.							
Sólo lo hago porque mi doctor me lo ordena.							
Personalmente, siento que cuidar mi dieta y ejercicio son lo mejor para mí.							
Me sentiría culpable si no cuidara mi dieta y ejercicio.							
Ejercitarse regularmente y seguir mi dieta son elecciones que realmente quiero hacer.							
Es un reto aprender a vivir con mi enfermedad.							

NPS

3.- En una escala del 0 al 10,

¿qué tan factible es que usted recomiende este producto o servicio a un amigo o colega?

0	1	2	3	4	5	6	7	8	9	10

Posicionamiento

4.- ¿Qué tan probable es que usted integre este sistema en las actividades que realiza relacionadas con su tratamiento?

a) Siempre b) Casi siempre c) Frecuentemente d) A veces e) Rara vez f)Nunca

5.- ¿Cómo la hizo sentir el sistema con respecto a la rutina que sigue en su tratamiento? ¿Qué efectos cree que tuvo?

6.- ¿Durante estas sesiones, comentó con alguien su experiencia usando este sistema?

7.- ¿Qué esperaría del sistema en el futuro? ¿Algo que añadir? ¿Cambiar? ¿Quitar?

No. de participante: _____

APPENDIX H: EMOTIONAL ENGAGEMENT AND NARRATIVE UNDERSTANDING QUESTIONS

Emotional Engagement

The story affected me emotionally

During the episode, when a main character succeeded, I felt happy, and when they suffered in some way, I felt sad.

I felt sorry for some of the characters in the story.

Narrative Understanding

At points, I had a hard time making sense of what was going on with the story.

My understanding of the characters is unclear.

I had a hard time recognizing the thread of the story.

APPENDIX I: GLUCOSE & BLOOD PRESSURE MEASUREMENTS FROM PARTICIPANTS

	Sessions				
Participant ID	**S1**	**S2**	**S3**	**S4**	**S5**
zmm6m	110/73	107/76	129/77	125/70	118/78
i87zr	127/93	119/80	133/81	108/77	122/81
64zrs	125/73	113/73	128/90	109/75	120/80
vuy2y2	304	347	159	125	104
yrs75	172	156	128	167	143
jjdva	120/74	119/75	126/77	109/65	111/79
ewdof	124/77	141/83	134/87	130/77	157/81
jde7y	138/81	133/76	118/79	122/67	109/76
am7sr	137/80	140/91	115/67	149/88	125/73
qf5t5	328	374	201	246	146

	Blood pressure measurement (in mm Hg)
	Glucose measurement (in mg/dL)

APPENDIX J: USABILITY PROBLEMS

ID	Severity	Category	Issue	Recommendation
P1	Minor	Error prevention	Reading became difficult as either a complication from age (i.e. poor eyesight) or an effect of higher values in glucose or blood pressure.	Provide option to adjust font-size and recommend doing so when blood pressure or glucose levels are high.
P2	Major	Match between system and real world	Participants, at times, found it difficult to manipulate the mousepad or find the cursor on screen.	A touchscreen is preferred for patients to have a more direct control of the interface.
P3	Major	Visibility of system status	Confusion as to whether there were sections still missing to be read.	Add a progress bar (preferably with a numeric identifier) to recognize the amount of sections left to complete the episode.
P4	Major	Visibility of system status / Help recognize errors	Alerts displaying an error were not properly identified.	Customize alert boxes to make then bigger and brighter, as Chrome's alerts were not recognized.
P5	Minor	User control and freedom	QWERTY keyboard was not recognized immediately to enter ID and/or measurement.	ID Card scanning instead of typing code would provide a simpler way to be identified. Automatic update of blood pressure or glucose could also be encouraged.
P6	Minor	Visibility of system status	Scrolling feature was not acknowledged at times.	Option 1: Adjust content to fit on screen without needing scrollbars to go through it. Option 2: increase size of scrollbars to make them more noticeable.
P7	Minor	Visibility of system status / Help & documentation	Textboxes were not identified as such and participants expected an action immediately after typing values in them.	Option 1: Remove textboxes and obtain data from card scanner and medical devices. Option 2: Highlight buttons upon filling of textbox and provide autofocus when previous items in the form have been completed

P8	Major	Technical	Images appear as broken links when unable to load.	Option 1: Download all media at once (i.e. once a week) Option 2: Remove images and provide text only.
P9	Minor	Help & documentation	Participants did not acknowledge dropdown menus. However, they did use them properly after no more than 2 sessions.	Provide a tutorial or agent to aid during the filling out of the form.
P10	Cosmetic	Aesthetics	Looping moving images (GIF) were found disturbing at times.	Option 1: Provide short videos that play only once. Option 2: Provide still images instead of GIFs.
P11	Minor	Comment	True / False questions were hard to understand.	Utilize Yes / No options instead as they make it easier for participants to understand.